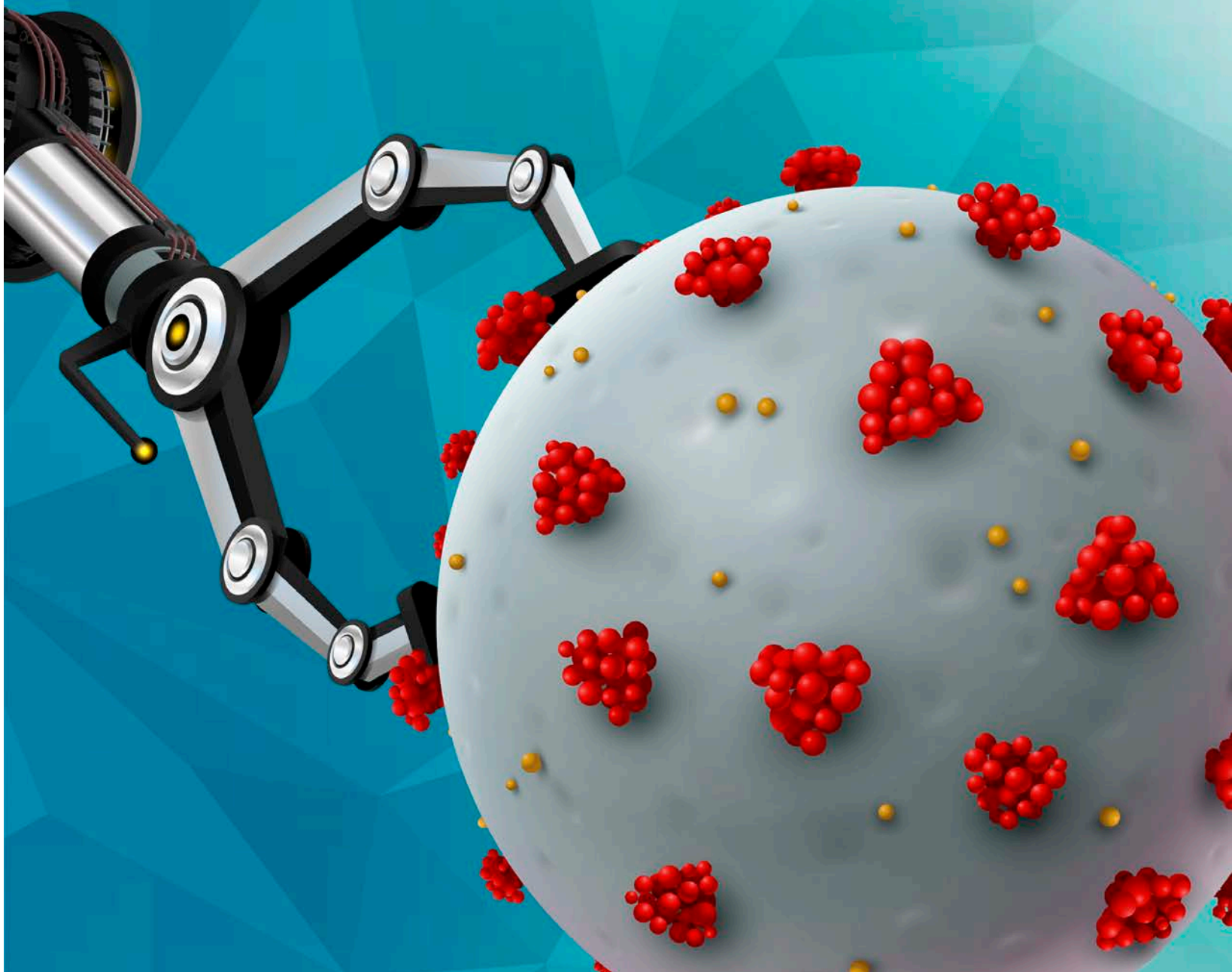




2^{do} CONGRESO INTERNACIONAL
DE INGENIERÍA BIOMÉDICA Y
BIOINGENIERÍA (CI-IB&BI 2021)

Memorias



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Memorias & Book of Abstracts

IEEE 2do Congreso Internacional de
Ingeniería Biomédica y Bioingeniería (CI-IB&BI 2021)
Octubre 13, 14 y 15 de 2021
Congreso Virtual

COMITÉ ORGANIZADOR



Mario Valderrama
Co-director CI-IB&BI 2021



Juan Carlos Cruz
Co-director CI-IB&BI 2021



Ana María Rudas
Coordinadora de
Comunicaciones y
de Logística



Camila Botero
Coordinadora de
Relaciones Públicas



Cristian Rodríguez
Gestor logístico



Maria Alejandra Castilla
Co-organización del foro y
el *challenge* estudiantil



María Camila Hernández
Web Master



Nathalia Huertas
Diseñadora

COMITÉ ORGANIZADOR – UNIVERSIDADES ALIADAS

Universidad del Rosario

Álvaro Orjuela - codirector del programa de Ingeniería Biomédica

Universidad ECCI

Ricardo Espinosa - profesor de la dirección de Ingeniería Biomédica

Universidad EIA

Carolina Castaño - directora de Ingeniería Biomédica

Universidad CES

Carolina Londoño - jefe del programa de Ingeniería Biomédica

Catalina Pineda - Líder de investigación e innovación de la Facultad de Ingeniería

Universidad Autónoma de Occidente

Camilo Ernesto Torres - director del programa de Ingeniería Biomédica

Universidad Autónoma de Bucaramanga

Alejandro Arboleda - director de programa de Ingeniería Biomédica

Universidad Militar Nueva Granada

Rubén Darío Hernández - profesor del Departamento de Ingeniería Biomédica

Angélica María Ramírez - profesora del Departamento de Ingeniería Biomédica

Universidad Tecnológica de Bolívar

Sonia Contreras - directora del programa de Ingeniería Biomédica

COMITÉ LOGÍSTICO ESTUDIANTIL

RED COLBI

Daniel López - vicepresidente administrativo

Catherine Cortes - secretaria y community manager (sección Medellín-Manizales)

Consejo Estudiantil de Ingeniería Biomédica (CESIB)

María Alejandra Hoyos – Representante estudiantil

Valentina Muñoz – Representante estudiantil

Organiza



En conjunto con



Apoya



Patrocina



Mensaje de BIENVENIDA



Mario Valderrama
Chair CI-IB&BI 2021



Juan Carlos Cruz
Chair CI-IB&BI 2021

El Departamento de Ingeniería Biomédica de la Universidad de los Andes en asociación con la Red Nacional de Programas de Ingeniería Biomédica y Bioingeniería, le dan la bienvenida al **IEEE 2do Congreso Internacional de Ingeniería Biomédica y Bioingeniería (CI-IB&BI 2021)**.

El CI-IB&BI 2021 fue organizado en formato virtual por el Departamento de Ingeniería Biomédica de la Universidad de los Andes, durante los días 13, 14 y 15 de octubre de 2021. El Congreso se realizó en conjunto con la Red Nacional de Programas de Ingeniería Biomédica y Bioingeniería, la Sección Colombia de la sociedad IEEE - Institute of Electrical and Electronics Engineers y los Capítulos Colombianos IEEE EMB - Medicine and Biology Society y IEEE CAS - Circuits and Systems Society. Además, estuvo patrocinado por Boston Scientific, Merck Sharp & Dome (MSD), la IEEE, Ortomac y Plastinovo, y recibió el apoyo de la Red Colombiana de Estudiantes de Ingeniería Biomédica y Bioingeniería (RED COLBI) y el Consejo Estudiantil de Ingeniería Biomédica - Uniandes (CESIB).

El CI-IB&BI 2021, centrado en el tema “la Ingeniería para la postpandemia”, ofreció a sus participantes cuatro cursos pre congreso en las áreas de Biomecánica, Modelado Computacional, Inteligencia Artificial y Señales Biomédicas con destacados profesores. También, sesiones plenarias con 23 Key-note Speakers nacionales e internacionales (los países invitados fueron Bélgica, Brasil, Chile, España, Estados Unidos, Perú, Singapur, Suecia, Suiza y Uruguay). Además de sesiones de presentaciones de proyectos de investigación en modalidad oral y de poster, un challenge estudiantil en equipos interinstitucionales auspiciado por el sector externo, un foro con panelistas destacados en la academia, la industria y el sector salud, y diferentes charlas empresariales.

Los autores del CI-IB&BI 2021 presentaron trabajos en las siguientes áreas:

- Imágenes Biomédicas
- Bioinformática
- Bioinstrumentación
- Biomateriales
- Biomecánica
- Biotecnología
- Dinámica Cardiovascular
- Genética y Genómica
- Ingeniería de Tejidos
- Inteligencia Artificial en Ingeniería Biomédica y Bioingeniería
- Logística Hospitalaria
- Modelado y Simulación de Sistemas Biológicos
- Procesamiento de Señales

INFORMACIÓN GENERAL

Fecha:

13, 15 y 15 de octubre de 2021

Todos los horarios del programa se presentan en la zona horaria de Colombia (GMT-5)

Modalidad:

Virtual – Plataforma Zoom Webinar

Página Web:

<https://ciibbi.uniandes.edu.co>

Idiomas oficiales:

Español e inglés

Grabaciones:

Las grabaciones de las sesiones plenarias estuvieron disponibles para que los asistentes del evento puedan descargarlas durante los siguientes 90 días al Congreso.

Logo:

La escogencia del logo se hizo a través de un concurso organizado por la RED COL-BI y el Consejo Estudiantil de Ingeniería Biomédica de la Universidad de los Andes (CESIB). El concurso estuvo dirigido a estudiantes de universidades pertenecientes a la Red Nacional de Ingeniería Biomédica y Bioingeniería. En total se recibieron 18 propuestas de logo y el Comité Organizador del evento compuesto por miembros de todas las universidades aliadas escogieron el diseño de María Alejandra Barrera,



estudiante del Departamento de Ingeniería Biomédica – Uniandes, como el ganador. Desde ese momento el diseño de la estudiante se convirtió en la imagen oficial del evento.

“Para mi este diseño integra la idea de la Ingeniería Biomédica y la Bioingeniería. Es decir, refleja la aplicación del conocimiento numérico e ingenieril a la naturaleza”,
explica María Alejandra Barrera.



2^{do} CONGRESO INTERNACIONAL
DE INGENIERÍA BIOMÉDICA Y
BIOINGENIERÍA (CI-IB&BI 2021)

CONFERENCISTAS INTERNACIONALES



Walter Curioso
Vicerrector de investigación
Universidad Continental, Perú.



Antonio Gómez
Director de investigación,
Clínica Podoactiva, España.



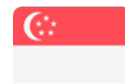
Giovanni Volpe
Profesor titular
Göteborgs Universitet, Suecia.



Georges Gielen
Profesor titular
Katholieke Universiteit
Leuven, Bélgica.



María Ángeles Pérez
Profesora titular
Universidad de Zaragoza,
España.



Jerald Yoo
Profesor asociado
National University of
Singapore.



Dany Jair Munoz
Profesor asociado
Trinity University, EE. UU.



Daniel Matute
Profesor asociado
University of North
Carolina, EE. UU.



Roberto Lavarello
Profesor principal
Pontificia Universidad Católica
de Perú (PUCP).



Gregory Wiedman
Profesor asistente
Seton Hall University,
Estad EE. UU.



Leonardo Abdala Elias
Profesor asistente
Universidade Estadual
de Campinas, Brasil.



Manuel Cuadra
Profesor adjunto
Universidad Tecnológica
del Uruguay (UTEC).



Esteban Aedo Muñoz
Profesor Universidad de
Santiago de Chile.



Daniel Restrepo
Investigador Postdoctoral
North Carolina State
University, EE.UU.



Mario Chavarría
Científico
L'ecole Polytechnique Federale
de Lausanne (EPFL), Suiza.

CONFERENCISTAS NACIONALES



Miguel Bernal
Científico Líder de Aplicaciones
Biomédicas en Verasonics SAS,
Colombia



Alher Mauricio Hernández
Profesor titular
Universidad de
Antioquia



Andrés Mauricio González
Profesor
Universidad Autónoma de
Occidente (AUO)



Lusvin Javier Amado
Líder línea Biomecánica
e Ingeniería de
Rehabilitación.
Universidad Autónoma
de Bucaramanga



Silvia Milena Becerra
Líder línea de Genética y
Biología Molecular.
Universidad Autónoma de
Bucaramanga



Victor Alfonso Solarte
Líder línea de
Biomateriales
e Ingeniería de Tejidos.
Universidad Autónoma
de Bucaramanga.



Catalina Pineda
Líder investigación e innovación
Universidad CES.



Marcela Mercado
Directora ejecutiva
In Silico Science and
Engineering SAS

CURSOS PRE CONGRESO

Análisis de la Biomecánica en el fútbol: Sistemas cinemáticos y cinéticos en la prevención de lesiones.



El gesto deportivo del fútbol implica gran cantidad de movimientos técnicos que deben de ser analizados para relacionar la biomecánica del jugador con la aparición de una posible lesión. Desde un análisis básico de la biomecánica hasta el gesto deportivo más complejo simulado en laboratorio, en este curso se abordó la cinética y la cinemática con diferentes sistemas de análisis. Se explicó detalladamente el funcionamiento y aplicación de las plantillas instrumentadas con sensores de presión, sistemas de fotocélulas para cuantificar la marcha y la carrera, plantillas inteligentes con presión e IMU integrado en la bota del jugador, sistemas de cinemática angular basado en marcadores y markerless. El objetivo principal se centró en que el alumno integrara las bases necesarias para el manejo de estos equipos con un criterio correcto, enfocado a podología deportiva.

Profesor: Antonio Gómez, director de investigación, Clínica Podoactiva. Profesor de Biomecánica en la Universidad de Manresa. Podólogo en SD Huesca.

Neural Interfaces for Controlling Finger Movements



Brain machine interfaces or neural prosthetics have the potential to restore movement to people with paralysis or amputation, bridging gaps in the nervous system with an artificial device. Microelectrode arrays can record from up to hundreds of individual neurons in motor cortex, and machine learning can be used to generate useful control signals from this neural activity. Performance can already surpass the current state of the art in assistive technology in terms of controlling the endpoint of computer cursors or prosthetic hands. The natural next step in this progression is to control more complex movements at the level of individual fingers. Our lab has approached this problem in three different ways. For people with upper limb amputation, we acquire signals from individual peripheral nerve branches using small muscle grafts to amplify the signal. Human study participants have been able to control individual fingers on a prosthesis using indwelling EMG electrodes within these grafts. For spinal cord injury, where no peripheral signals are available, we implant Utah arrays into finger areas of motor cortex, and have demonstrated the ability to control flexion and extension in multiple fingers simultaneously. Decoding “spiking band” activity at much lower sampling rates, we also recently showed that power consumption of an implantable device could be reduced by an order of magnitude compared to existing broadband approaches, and fit within the specification of existing systems for upper limb functional electrical stimulation. Finally, finger control is ultimately limited by the number of independent electrodes that can be placed within cortex or the nerves, and this is in turn limited by the extent of glial scarring surrounding an electrode. Therefore, we developed an electrode array based on 8 μ m carbon fibers, no bigger than the neurons themselves to enable chronic recording of single units with minimal scarring. The long-term goal of this work is to make neural interfaces for the restoration of hand movement a clinical reality for everyone who has lost the use of their hands.

Profesora: Cynthia Chestek, profesora asociada del Departamento de Ingeniería Biomédica. University of Michigan, EE. UU.



Introducción al Análisis de Elementos Finitos (FEA) con COMSOL Multiphysics



Este curso ofreció un entrenamiento nivel básico para comenzar la carrera en el mundo de la Ingeniería Asistida por Computador. El estudiante aprendió las bases para implementar modelos matemáticos y simular en COMSOL Multiphysics con un ejemplo aplicado. COMSOL Multiphysics es un paquete de software de análisis y resolución por elementos finitos para varias aplicaciones físicas y de ingeniería, especialmente fenómenos acoplados, o multifísicos. El contenido del curso se presenta a continuación: Introducción, pre análisis: modelado matemático de la realidad multifísica, preprocesado: implementación del modelo matemático en COMSOL Multiphysics, procesado: simulación en COMSOL Multiphysics, postprocesado: extracción de resultados de simulación en COMSOL Multiphysics, introducción a la creación de aplicaciones en COMSOL Multiphysics.

Dirigido a estudiantes y profesionales de todas las ingenierías, ciencias naturales y matemáticas.

Profesora: Marcela Mercado, directora ejecutiva de In Silico Science and Engineering SAS



En Bioingeniería, las herramientas de Machine Learning ganan cada vez mayor interés dado su gran número de aplicaciones. En áreas como Genética, Neurociencias, Epidemiología o Biotecnología, los sistemas biológicos se pueden modelar con estas herramientas para entender su funcionamiento y predecir su comportamiento.

En este curso, se mostraron algunos tipos de datos utilizados para resolver preguntas en Biología y Medicina. Además, se presentó la teoría básica de Machine Learning, haciendo énfasis en algoritmos supervisados y no supervisados en tareas de clasificación, agrupamiento, detección o estimación. Se discutieron algunos desafíos particulares encontrados en aplicaciones en Bioingeniería, tales como: tamaño de la muestra, clases no balanceadas o etiquetado de los datos. También, se presentaron algunas de las aplicaciones más novedosas en el estado del arte y en las industrias de *eHealth* y *Biotech*. Finalmente, se realizó una sesión *hands-on-data* donde los participantes podrán interactuar con los datos e implementar tareas de clasificación automática a partir de señales e imágenes en problemas específicos de Bioingeniería.

Profesora: Catalina Alvarado Rojas, profesora asistente del Departamento de Ingeniería Electrónica de la Pontificia Universidad Javeriana, Colombia.

CHARLAS EMPRESARIALES



Boston Scientific
Advancing science for life™

Catalina López
Remote Solutions and
Emerging Technologies
Manager LATAM.
Boston Scientific





2^{do} CONGRESO INTERNACIONAL
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BIOINGENIERÍA (CI-IB&BI 2021)

**¿Cómo navegar el ecosistema de la salud
en tiempos de economía low-touch?**

Jueves, 14 de octubre - 5:00pm

Charla Empresarial



La era postpandemia ha formado nuevos hábitos y regulaciones, basados en una reducción de interacción física y de proximidad. Esta disrupción ha cambiado la forma en que comemos, trabajamos, compramos, nos ejercitamos, gestionamos nuestra salud, socializamos e inclusive pasamos nuestro tiempo libre. La finalidad de esta charla fue entender el impacto de la economía low-touch en el ecosistema de salud, explorando la transformación de la industria tras el protagonismo que adquieren la digitalización y la virtualidad, donde aparecen nuevas oportunidades y evoluciona la forma en que entregamos los servicios en salud.



Fernando Martinez
Lead Clinical Scientist -
CSSM
MSD





2^{do} CONGRESO INTERNACIONAL
DE INGENIERÍA BIOMÉDICA Y
BIOINGENIERÍA (CI-IB&BI 2021)

MSD - inventing for life

Viernes, 15 de octubre - 2:00 p.m

Charla Empresarial



Esta charla abordó la investigación en MSD Colombia, el legado de la compañía y el cambio del proceso de innovación a través del tiempo. Se habló de las razones por las que hacer parte del mundo de investigación es una opción interesante.



Juan Carlos Robledo
Gerente General ORTOMAC



Jefferson Infante
Gerente Técnico ORTOMAC





2^{do} CONGRESO INTERNACIONAL
DE INGENIERÍA BIOMÉDICA Y
BIOINGENIERÍA (CI-IB&BI 2021)

**Tecnologías CAD / CAM / CAE / Impresión
3D, utilizadas en la industria médica**

Viernes, 15 de octubre - 2:00 p.m

Charla Empresarial



En esta charla, directivos de ORTOMAC hicieron una presentación de las diferentes líneas de aplicación de los dispositivos médicos para ortopedia, neurocirugía y cirugía maxilofacial. También, explicaron las tecnologías CAD, CAM, CAE e Impresión 3D: modelado, validación, usos, características y ventajas. Además de casos de éxito en la aplicación de estas tecnologías en cirugías de implantes personalizados para ortopedia, cirugía maxilofacial y neurocirugía, mostrando el proceso desde la patología asociada al paciente hasta el resultado final.

RETO DE INNOVACIÓN: INGENIERÍA POSTPANDEMIA

Del 8 al 11 de octubre de 2021 se desarrolló el Reto de Innovación: Ingeniería Postpandemia para estudiantes de programas de Ingeniería Biomédica o Bioingeniería.

El Comité Organizador conformó 18 equipos interinstitucionales con un total de 90 estudiantes inscritos, los cuales compitieron por un premio de cinco millones de pesos (\$5.000.000) para el primer puesto y tres millones quinientos mil pesos (\$3.500.000) para el segundo puesto.

El reto que recibieron los equipos fue: el desarrollo basado en tecnología para la administración eficiente de enfermedades crónicas no transmisibles en post-pandemia, solución desde la low touch economy.

El reto incluía la entrega de:

- Pitch deck (video y audio de la presentación de la solución, modelo de negocio y prototipado 3-5 min).
- Prototipo funcional (simulación, mockup, contenido audiovisual interactivo, o herramientas digitales)
- Reporte corto (2 páginas).



GANADORES

PRIMER PUESTO



Elizabeth Sánchez
-Escuela Colombiana de
Ingeniería Julio Garavito
-Universidad del Rosario



Carolina Sánchez
Universidad CES



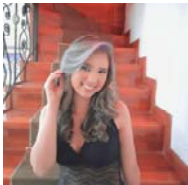
Carlos Suárez
Universidad de los Andes



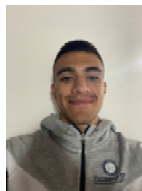
Juliana Home
Universidad
Santiago de Cali

Asesor: Leonardo Bermeo
Universidad Santiago de
Cali

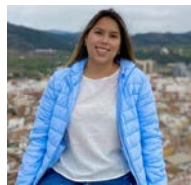
SEGUNDO PUESTO



María Alejandra González
Instituto Politécnico Universitario
Territorial Agroindustrial del
Táchira



Mario Andrés Ceballos
Universidad CES



Natalia Lizcano
Universidad EIA



Jhon Esteban Guerrero
Universidad Santiago de Cali

Asesora: Natalia Suárez
Universidad de los Andes

FORO: ¿CUÁL ES EL ROL DE LA INGENIERÍA EN LA POSTPANDEMIA?

La Ingeniería tiene como horizonte aportar soluciones ante problemas de su entorno para contribuir al bienestar y al desarrollo social, a través de la aplicación de conocimientos en Matemáticas, Física y áreas de conocimiento afines. Este rol vuelve al ingeniero un profesional esencial durante y después de la pandemia ocasionada por el COVID-19. El tema principal de este foro fue hablar del rol de la Ingeniería en la Postpandemia y los retos que afronta el profesional en ingeniería Biomédica y Bioingeniería en el país en esta nueva era digital.

¿Cuál es el rol de LA INGENIERÍA EN LA POSTPANDEMIA ?
Un diálogo reflexivo entre la academia, la industria y el sector público.

2º CONGRESO INTERNACIONAL DE INGENIERÍA BIOMÉDICA Y BIOINGENIERÍA (CI-IB&BI 2021)

Viernes 13 de octubre - 3:00 pm

LUIS HERNÁNDEZ
Director de Investigación
Facultad de Medicina
Unandes

ERICKA QUIRADOS
Directora LATAM Quality &
Regulatory Medtronic

JUAN MANUEL CORDOVEZ
Vicedecano de Investigación e
Innovación Facultad de Ingeniería
Unandes

CAMILO ARENAS
Gerente de Asuntos Corporativos y
Públicos en Boston Scientific

MAURICIO ECHAVARRÍA
Director Unidad de Negocios
Fresenius Medical Care Colombia

FERNANDO GARCÍA
CEO y Co-Founder HED Health
Engineering Design

ALEJANDRA CASTILLA
Fundadora @linkiapp y
conferencista TEDx

ÁLVARO QUINTERO
Director de Innovación Instituto
Nacional de Cancerología

Sponsors: Universidad de los Andes, Boston Scientific, HED, Instituto Nacional de Cancerología-ESE, linki, FRESNIUS MEDICAL CARE, Medtronic

El foro abordó un diálogo reflexivo entre diferentes actores de la academia, la industria y el sector público.

PREMIACIÓN

Mejores presentaciones orales:

- #38 Chitosan methacrylate-based bioadhesive: towards a photoresponsive and extrudable material for bone fracture repair.

Daniela N. Céspedes-Valenzuela, Santiago Sánchez-Rentería, Carolina Muñoz-Camargo y Juan C. Cruz (Universidad de los Andes).

- #40 ROG for biomedical semantic segmentation of lung cancer tumors.

Felipe Escallón Páez y José M. Abril-Nova (Universidad de los Andes).

- #89 Preparation and characterization of chitosan/gelatin /PVA scaffolds for tissue engineering application.

Yesenia Sánchez Cardona, Martha Elena Londoño López, Claudia Elena Echeverri Cuartas (Universidad EIA) y Natalia Rocío Moreno Castellanos (Universidad Industrial de Santander).

Mejor poster:

- #38 Chitosan methacrylate-based bioadhesive: towards a photoresponsive and extrudable material for bone fracture repair.

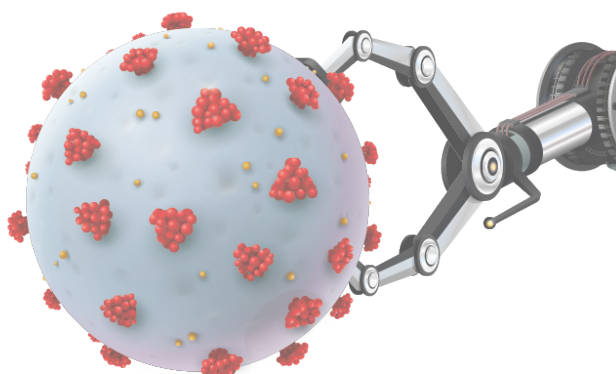
Daniela N. Céspedes-Valenzuela, Santiago Sánchez-Rentería, Carolina Muñoz-Camargo y Juan C. Cruz (Universidad de los Andes).

- #40 ROG for biomedical semantic segmentation of lung cancer tumors.

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Yesenia Sánchez Cardona, Martha Elena Londoño López, Claudia Elena Echeverri Cuartas (Universidad EIA) y Natalia Rocío Moreno Castellanos (Universidad Industrial de Santander).





Cursos Pre Congreso

7:00 a.m. -10:00 a.m.	Análisis de la Biomecánica en el fútbol: Sistemas cinemáticos y cinéticos en la prevención de lesiones Antonio Gómez	+	7:00 a.m. -10:00 a.m.	Introducción al Análisis de Elementos Finitos (FEA) con COMSOL Multiphysics Marcela Mercado	+
10:00 a.m. - 1:00 p.m.	Neural Interfaces for Controlling Finger Movements Cynthia Chestek	+	10:00 a.m. - 1:00 p.m.	Aplicaciones de Machine Learning en Biología y Medicina Catalina Alvarado	+

*Estos cursos están disponibles para quienes hayan llenado su inscripción respectiva y tendrán salas alternas que las designadas para el resto del evento.

CI -IB&BI 2021

Sesiones Plenarias

Sala A

-1:45 p.m.	Apertura Congreso	+
2:00 p.m. -3:00 p.m.	Sesión plenaria: La telesalud en tiempos del COVID-19: Expandiendo el desarrollo de competencias interdisciplinarias Walter Curioso	+

Presentaciones Orales

Sala B

3:00 p.m. - 5:30p.m.	Bioinstrumentación Señales Inteligencia Artificial	+
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Sala C

3:00 p.m. 5:30 p.m.	Biomecánica Biomateriales	+
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Sesiones Plenarias

Sala A

5:45 p.m. -6:45 p.m.	Body Area Network – Connecting and Powering Things Together Around the Human Body Jerald Yoo	+
-------------------------	---	---

Sesiones Plenarias		
Sala D 7:00 a.m. Biomedical sensing and stimulation to relieve chronic stroke patients -8:00 a.m. Georges Gielen		
Sala A 8:00 a.m. Modelos de regeneración ósea y modelos computacionales asociados -8:45 a.m. María Ángeles Pérez	Sala B 8:00 a.m. Designing Microenvironments for the in Vitro Culture and Evaluation of the Biological Responses of Central Nervous System Cells to Matrix-derived Stimuli. -8:45 a.m. Dany Jair Munoz	Sala C 8:00 a.m. Modelos genómicos para la detección de flujo genético entre especies -8:45 a.m. Daniel Matute
Presentaciones Orales		
Sala D 9:00 a.m. Biomateriales -11:30 a.m. Ingeniería de Tejidos Imágenes Biomédicas	Sala E 9:00 a.m. Bioinstrumentación -11:30 a.m. Bioinformática Modelación y Simulaciones	
Sesiones Plenarias		
Sala A 11:45 a.m. Multiomics to Connect Phenotype to Genotype -12:30 p.m. Daniel Restrepo 1:15 p.m. Experiencias asociadas al desarrollo de una tecnología de bajo costo orientada al diagnóstico vascular no invasivo -2:00 p.m. Manuel Cuadra	Sala B 11:45 a.m. Bridging the gap between computational and experimental neuroscience to understand the neurophysiological control of movement -12:30 p.m. Leonardo Abdala Elias 1:15 p.m. Considering Synergistic Mechanisms in Antimicrobial Peptide Design -2:00 p.m. Gregory Wiedman	Sala C 11:45 a.m. Innovación asistida por computador para el cuidado de la vida. -12:30 p.m. Marcela Mercado 1:15 p.m. Actividad electromiográfica de entrenamiento en altura, variaciones y actualizaciones -2:00 p.m. Esteban Aedo Munoz
Posters		
Sala D 2:15 p.m. Bioinstrumentación -4:55 p.m. Modelado/Bioinformática/Simulaciones Imágenes Biomédicas	Sala E 2:15 p.m. Genética / Biomecánica -4:55 p.m. Biomateriales / Ingeniería de Tejidos	
Sesiones Plenarias		
Sala A 5:00 p.m. Herramientas para el Análisis Biomecánico enfocado al deporte -5:45 p.m. Lusvin Amado	Sala B 5:00 p.m. Barreras y oportunidades para el desarrollo de empresas de base tecnológica en el área de la ingeniería biomédica en Colombia. -5:45 p.m. Mauricio Hernández	Sala C 5:00 p.m. ¿Cómo navegar el ecosistema de la salud en tiempos de economía low-touch? -5:45 p.m. Boston Scientific
Encuentros con universidades		
6:00 p.m. Oportunidades de crecimiento en el área de Ingeniería Biomédica en el país -6:30 p.m. Diana Rodríguez Universidad del Rosario	6:00 p.m. Conoce el programa de maestría en Ingeniería Biomédica de la Universidad de los Andes -6:30 p.m. Diana Gaitán Universidad de los Andes	

Sesiones Plenarias		
Sala D 7:00 a.m. Biomedical sensing and stimulation to relieve chronic stroke patients -8:00 a.m. Georges Gielen		
Sala A 8:00 a.m. Modelos de regeneración ósea y modelos computacionales asociados -8:45 a.m. María Ángeles Pérez	Sala B 8:00 a.m. Designing Microenvironments for the in Vitro Culture and Evaluation of the Biological Responses of Central Nervous System Cells to Matrix-derived Stimuli. -8:45 a.m. Dany Jair Munoz	Sala C 8:00 a.m. Modelos genómicos para la detección de flujo genético entre especies -8:45 a.m. Daniel Matute
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Posters		
Sala D 2:15 p.m. Bioinstrumentación -4:55 p.m. Modelado/Bioinformática/Simulaciones Imágenes Biomédicas	Sala E 2:15 p.m. Genética / Biomecánica -4:55 p.m. Biomateriales / Ingeniería de Tejidos	
Sesiones Plenarias		
Sala A 5:00 p.m. Herramientas para el Análisis Biomecánico enfocado al deporte -5:45 p.m. Lusvin Amado	Sala B 5:00 p.m. Barreras y oportunidades para el desarrollo de empresas de base tecnológica en el área de la ingeniería biomédica en Colombia. -5:45 p.m. Mauricio Hernández	Sala C 5:00 p.m. ¿Cómo navegar el ecosistema de la salud en tiempos de economía low-touch? -5:45 p.m. Boston Scientific
Espacio con patrocinadores		

Sesiones Plenarias		
Sala D 7:00 a.m. Deep Learning for Microscopy with Biomedical Applications -8:00 a.m. Giovanni Volpe +		
Sala A 8:00 a.m. Modulación de la respuesta inmune innata mediada por materiales biológicos compuestos por matriz extracelular -8:45 a.m. Catalina Pineda +	Sala B 8:00 a.m. Development of sustainable and context aware medical technology for low income communities. -8:45 a.m. Mario Chavarría +	Sala C 8:00 a.m. Tecnologías de análisis para la biomecánica en podología deportiva -8:45 a.m. Antonio Gómez +
Presentaciones Orales		
Sala D 9:00 a.m. Biomecánica -11:30 a.m. Bioinformática Modelado y Simulaciones +	Sala E 9:00 a.m. Imágenes Biomédicas -11:30 a.m. Señales Inteligencia Artificial +	
Sesiones Plenarias		
Sala A 11:45 a.m. Medicina Regenerativa en la era de la precisión -12:30 p.m. Silvia Becerra Victor Solarte +	Sala B 11:45 a.m. Formación y procesamiento de imágenes médicas -12:30 p.m. Roberto Lavarello Miguel Bernal +	Sala C 11:45 a.m. Herramientas de simulación online para el aprendizaje en el área de la bioinstrumentación -12:30 p.m. Andrés González +
Presentaciones Orales		
Sala A 1:15 p.m. Dispositivos Médicos -2:00 p.m. Biotenología +	Sala D 1:15 p.m. Dispositivos Médicos -2:00 p.m. Biotenología +	Sala E 1:15 p.m. Dispositivos Médicos -2:00 p.m. Biotenología Inteligencia Artificial +
Charlas Empresariales		
Sala B 2:00 p.m. MSD-inventing for life -2:45 p.m. MSD +	Sala C 2:00 p.m. Tecnologías CAD / CAM / CAE / Impresión 3D, utilizadas en la industria médica -2:45 p.m. ORTOMAC +	
Clausura		
Sala A 3:00 p.m. Foro: ¿Cuál es el rol de la Ingeniería en la pospandemia? -4:45 p.m. 5:00 p.m. Premiaciones y clausura -5:45 p.m. +		

AGRADECIMIENTOS

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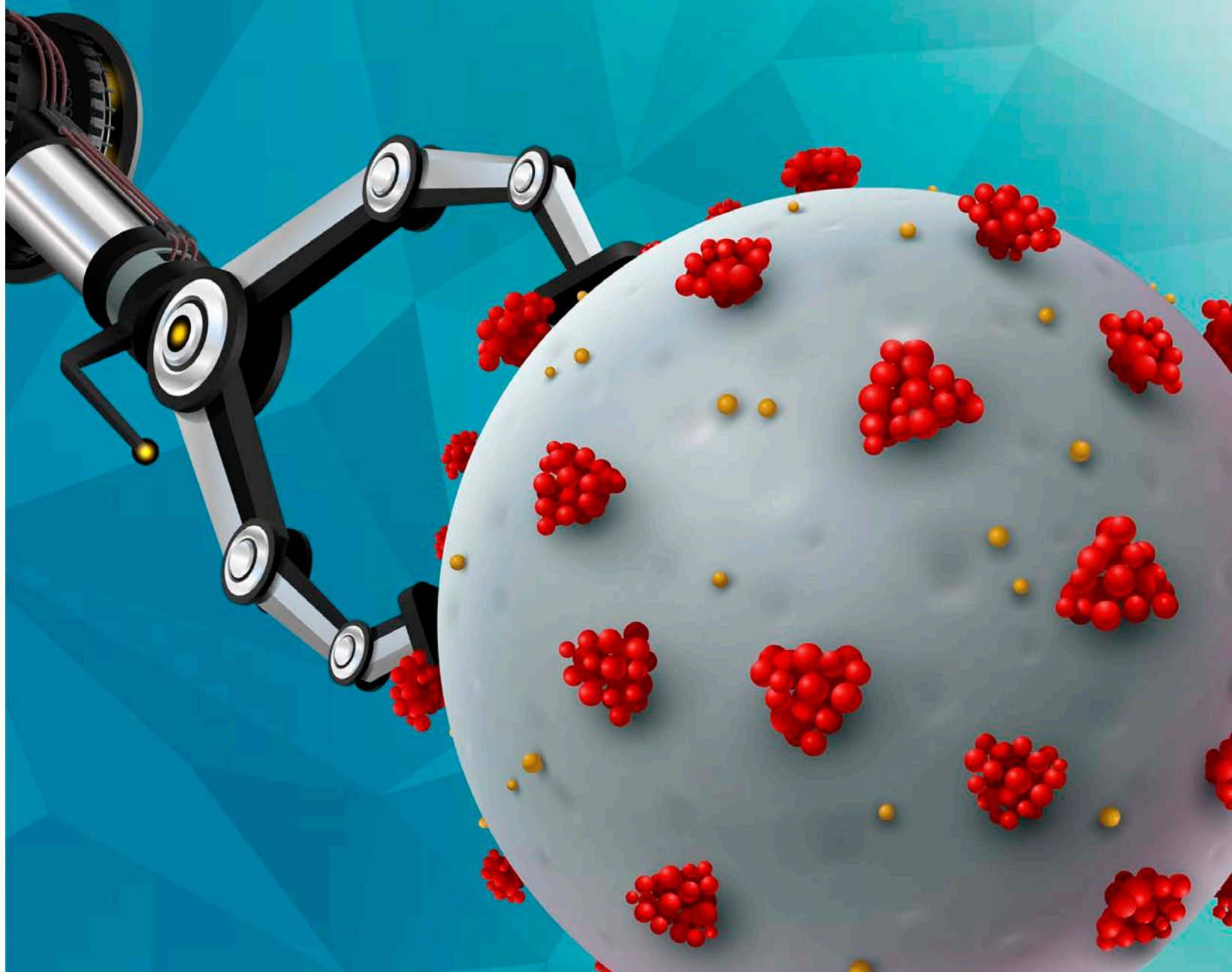
Universidad de los Andes | Vigilada Mineducación
Reconocimiento como Universidad: Decreto 1297 del 30 de mayo de 1964.
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DE INGENIERÍA BIOMÉDICA Y
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Book of Abstracts





2^{do} CONGRESO INTERNACIONAL
DE INGENIERÍA BIOMÉDICA Y
BIOINGENIERÍA (CI-IB&BI 2021)



Bioinformática

Molecular affinity between caffeic and chlorogenic acid with proteins associated with apoptosis pathways using docking molecular analysis

Myriam Liliana Agudelo-Quintero, Sandra Arango-Varela, Jorge Alejandro Lopera-Rodríguez and María Alejandra Llano-Ramírez

Modulation of apoptosis is necessary in the basic physiological response to cancer. However, in some cancer scenarios, apoptosis is inhibited allowing the tumor proliferation. Searching for new therapeutic agents that promote apoptosis in cancer is relevant. Among these potential agents are caffeic acid and chlorogenic acid. Several studies have evaluated the activity of polyphenols as modulators in the apoptosis process. This study evaluated the affinity of caffeic and chlorogenic acid for some proteins related with apoptosis pathway using docking molecular strategies. The pro and anti-apoptotic proteins included in the analysis were catalase, heat shock protein 27 (HSP27), P27/Kip1/CDKN, Bcl-XL, cytochrome C, PON2, H02-HM0X2, Bax. The crystallographic structures were downloaded from Protein Data Bank and ligands from PubChem. Preparation of the ligands was done in Avogadro 1.0 and proteins in Chimera 1.15. Docking experiments were implemented in Autodock Vina. Chlorogenic acid showed the best affinity with the proposed proteins. HSP27 presented a good affinity for the two ligands, with score affinity of -7,9 in caffeic acid and -9,0 in chlorogenic acid. In the same way, catalase presented a good affinity with -7,9 in score affinity in both ligands. The docking molecular analysis suggests potential pro-apoptotic functions for chlorogenic and caffeic acid considering their affinity with anti-apoptotic proteins.

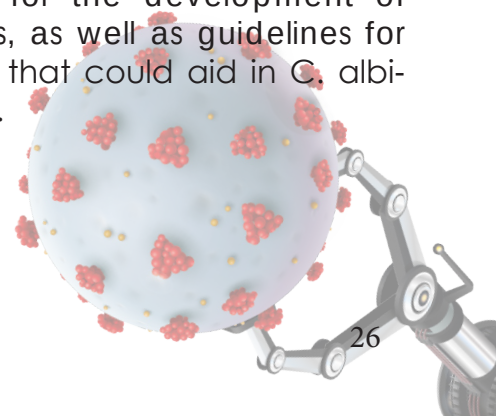
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Virtual screening of new targets and inhibitors for *Candida albicans* infection control

Laura Ellis-Aguilar, Laura Rueda, Javier Cifuentes, Camilo Velandia, Juan C Cruz, Carolina Muñoz-Camargo and Rodrigo Cabrera

Infection by *Candida albicans* fungus is considered of biomedical interest, producing significant mortality and comorbidity. The development of pathogen resistance during pharmacological treatments is increasing, thus, the pursuit for new inhibitors is necessary. Virtual screening is one of the bioinformatics tools used for the search of new drugs, and potential targets for disease management. The aim of the present study was to analyze a library of potential targets, and to identify suppressors for *C. albicans* using virtual screening. 50 protein targets with restraining potential were examined, choosing GPlanchored hemophore PGA10 protein (RBT5) as the target, since it is involved in *C. albicans* survival and nutrients acquisition. Meanwhile, through the implementation of AutoDock Vina and PyRx software, the molecular affinity of 25 molecules available in ZINC15 database was analyzed, obtaining favorable results for the following compounds: ZINC000000065058, ZINC000000065374 and ZINC000000072389, displaying affinity with the same region of the target protein. These results provide a potential target for the development of novel suppressors, as well as guidelines for three new drugs that could aid in *C. albicans* suppression.

ID: 92



Virtual screening of target sites in β -catenin for colorectal cancer treatment

Laura Catalina Vélez Vargas, Isabel Cristina Henao Castañeda and Nini Johanna Pedroza Díaz

During the COVID pandemic, the health systems focused on supporting the expansion and efficiency of intensive care units. Although the health care services established strategies to maintain the oncology and chemotherapy units, there was a significant decrease in access to diagnostics or cared for pathologies such as cancer[1]. Colorectal cancer (CRC) was third cancer with the highest mortality worldwide in 2020 [2], and about 30% of cases are associated with mutations in β -catenin, which constitutively activate the protein. It has been reported that 10% to 70% of cancer cases are related to diet [3]. About 90% of the CRC cases could be prevented by making changes since dietary deficiencies can alter the sensitivity to genetic damage and contribute to cancer development[4]. Coffee is a beverage with a higher concentration of polyphenols[5], a group of phytochemicals related to anticancer effects, including antiproliferative activity, DNA repair, apoptosis induction, anti-inflammatory activity; inhibition of angiogenesis, and metastasis[4]. To determine the target site of polyphenols in β -catenin as a promising colorectal cancer treatment. The six coffee polyphenols and the known β -catenin inhibitor iCRT14 and C2 were built using GaussView 5 [6] and were prepared using quantum chemical calculations in GAUSSIAN 09 [7]. The structure of the β -catenin (PDB code 2GL7) was prepared using UCSF Chimera [8] and Autodock Tools. Molecular docking was carried out using Autodock Vina [9], at two different sites: the well-known union site (US) ($x=2.805$, $y=14.864$ and $z=79.543$) and the recently reported allosteric site (AS) ($x=14.584$, $y=12.350$, $z=24.972$). After that, the pose with the best affinity was chosen, and a visual inspection

of the interactions at both sites was performed on Discovery Studio Visualizer [10], PLIP [11], and UCSF Chimera. As shown in Table 1, most of the studied polyphenols showed higher affinity to the US, except for 3-caffeoylquinic acid that has an affinity of -6.4 Kcal/mol at AS. However, the union between polyphenols and allosteric site was characterized for more hydrogen bonds interactions. Through the computational studies, we predicted that coffee polyphenols could interact with the β -catenin in both sites. Nevertheless, the studied compounds showed a more significant number of interactions with the allosteric site making it a suitable site for CRC treatment and deeper research.

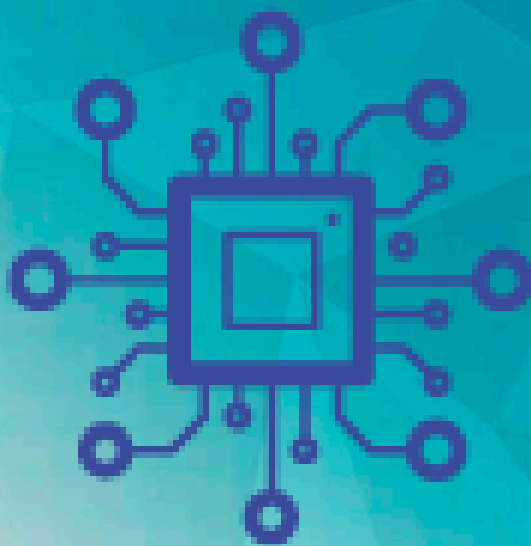
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Bioinstrumentación

Design and development of a mobile app to support the care of the elderly

William Ricardo Rodríguez Dueñas, Karen Aguia Rojas and Valeria Valencia Daza

Aging is a natural process that increases the risk of disease and reduces capabilities. It is a rapidly increasing phenomenon in low -and middle- income countries, and received considerable attention during the COVID-19 pandemic. The elderly were at greater risk in the pandemic due to greater number of comorbidities and special care needs. Some require direct or indirect care provided by their family or caregivers; however, in some cases, older persons were obliged to care for themselves or other older persons assumed the role of caregiver. Although there are some technologies that support the basic and instrumental activities of daily living for older persons, these are not always affordable or available in countries like Colombia. This project proposes the development of an app for mobile devices that facilitates the care and monitoring of older persons by family members, caregivers, or for self-care. We propose a user-centered design methodology for the design of the app and the rapid software development methodology for its creation. Finally, we conducted a usability pilot study to determine the viability of the tool. The results are satisfactory and show that the tool is feasible and will positively impact end users.

ID: 5

Paper biosensor based on gold nanoparticles for the rapid detection of respiratory tract infections caused by *Pseudomonas aeruginosa*.

Francy Alejandra Alba Patiño, Antonio Clemente and Roberto De la Rica

Poor patient outcomes associated with respiratory infections by *Pseudomonas aeruginosa* could be improved with a rapid analysis of respiratory samples (e.g. sputum) leading to a prompt administration of appropriate antibiotics. However, due to the protective biofilms created by the pathogen and the high viscosity of the sputum matrix it is difficult to analyze this kind of sample with a biosensor. Here, we introduce a paper biosensor based on nanoparticles that detects *Pseudomonas aeruginosa* in respiratory samples. Sputum samples can be analyzed thanks to a new sample treatment with hydrogen peroxide that enzymatically liquefies the matrix and disrupts bacterial biofilms within a minute. The limit of detection is $105 \text{ cells} \cdot \text{mL}^{-1}$, which is the clinical threshold value for respiratory infections. The test diagnostic sensitivity (true-positive rate) is 100%, and the specificity (true-negative rate) is 96.7%. The high sensitivity, rapid turnaround time (only 8 min) and the fully automated realtime densitometry app make our diagnostic kit ideal for the rapid screening of *P. aeruginosa* infections at the point of care.

ID: 6



In silico study of spheroids fusion through magnetic field gradients

Cristian Felipe Rodríguez Ospino, Laura Ortiz Calderon, Kevin Alejandro Giraldo Rodríguez, Carolina Muñoz Camargo and Juan Carlos Cruz Jimenez

Controlling cell interactions and how they form aggregates represents one of the main challenges in the cellular engineering field, especially when dealing with emerging 3D bioprinting applications. In vivo cells are known for their self-assembling capability at microscales into complex functional configurations such as spheroids and organoids. However, in vivo experimentation has failed to find the optimal conditions to recreate complex heterogeneous architectures, cell-cell, and extracellular matrix (ECM) in vivo interactions. This work is therefore dedicated to studying in silico interactions of spheroids embedded with magnetic nanoparticles. The main goal was to identify the key parameters responsible for forming complex 3D architectures in a controlled manner by applying magnetic fields. The obtained results showed that magnetized spheroids fuse to each other quite rapidly by the action of the applied magnetic fields. The fusion process agreed well with previous reports for unmagnetized spheroids; however, the model should be refined further by experimental testing to calibrate the fusion times. Despite the limitations, the presented approach confirms that the 3D assembly of cell aggregates is attainable through controlled magnetic fields gradients. This is useful to enable emerging applications in tissue engineering and 3D bioprinting that require the assembly of 3D living architectures.

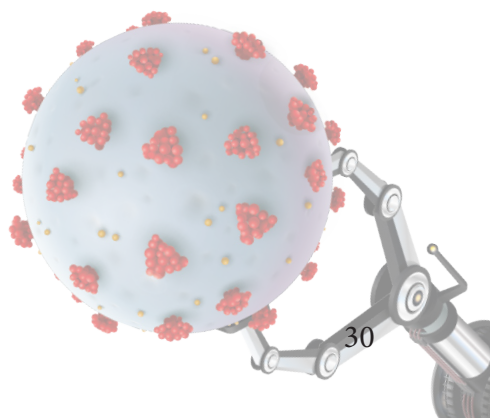
ID: 26

Low-cost, open source defibrillation analyzer for educational purposes

Edgar Sebastian Ramirez Diaz, Daniel Felipe Bustos Rodríguez and Andres Mauricio Gonzalez-Vargas

Defibrillator analyzers are very useful to understand how defibrillation works and how to use the different types of defibrillators. However, these analyzers are costly, and it is not always easy for a biomedical engineering laboratory to have several of these devices available for student practices. This paper presents the design, implementation and validation of a defibrillation analyzer focused on education. It has been designed with these features in mind: low cost, reliability, free open-source philosophy, easy to manufacture and simple to use by any student. It has an anthropomorphic shape of a human torso, with the ability to simulate cardiac signals with different types of arrhythmias, which in turns allows to perform a defibrillator shock and analyze the discharge signal, obtaining the amount of energy, the magnitudes of voltage and current and displaying the discharge waveform.

ID: 13



Electric Field Simulations Analysis to Obtain Functional Cardiomyocytes

Paola Andrea Neuta Arciniegas, Isabella Villota Espinosa and Isabella Ortiz Drada

The main cause of death worldwide is cardiac ischemia, an illness that produces the death of cardiomyocytes. These cells can't be replaced so the contractile function of the heart decreases. Tissue engineering promise is a solution to this problem through the development of a cardiac scaffold in vitro, to replace the necrotic tissue. The electric stimulation in vitro has shown improvement of the functional characteristics of the cardiomyocytes, being the electric field used in some studies to stimulate the cells before the implantation. This project evaluates the distribution and concentration of an electric field of an electrostimulation system. The system was designed like a circuit, formed by two electrodes with electric properties of graphite and an electrolytic solution represented by the cardiomyocytes differentiation medium. The electrodes were configured vertically and horizontally to study the field distribution; according to the selected electric field in the electrostimulation space. These simulations and the graphics presented were obtained with the software COMSOL Multiphysics. The results show the vertical configuration of the electrodes having the behavior of punctual charges while the horizontal configuration had parallel plaques behavior. Furthermore, the values of the electric field vary in the space near the electrodes because of the higher concentration of the field there. The horizontal configuration was determined as the best for the electrodes. Additionally, because of the higher concentration around the electrodes, the scaffold had to be placed at least 0,1 cm from them.

ID: 45

UAOSIM-ECG: An open-source 12-lead electrocardiography simulator

Juan Camilo Vergara Gil and Andres Mauricio Gonzalez-Vargas

This paper presents the design and implementation of an electrocardiography (ECG) simulator for educational purposes. The representation of the ECG leads is carried out using Fourier series instead of most common options such as look-up tables. The device is designed to produce simultaneous simulation of 12-lead signals and can be connected to any commercial ECG or vital signs monitor. All the design is open-source and openhardware, and the total cost of the components is significantly lower than commercial alternatives. The device's performance was validated, obtaining a mean and maximum relative error of 1.8% and 3%, respectively, and an uncertainty of ± 1 at 50 bpm and ± 3 at 250 bpm. This design could help biomedical programs to have more availability of simulators to facilitate hands-on learning for students in biomedical instrumentation courses.

ID: 43



Fluorescence phenomenon evaluation associated to the interaction of carbon dots with immunoreagents

Manuel Santiago Moncada Barrera and Marisol Jaramillo Grajales

There are several types of biosensors, among them are optical biosensors, which have been of great interest because they allow a response in real time. Recently, optical biosensors based on carbon dots (CDs) have been developed and an increase in sensitivity and specificity has been evidenced due to CDs are a material that has fluorescent properties much better than those of traditional fluorescent markers. Taking into account the aforementioned, in this study the fluorescence phenomenon of CDs conjugated with bovine serum albumin (BSA) was evaluated through the quenching of fluorescence with graphene oxide (GO) and the recovery of fluorescence with BSA antibody (anti-BSA) as a starting point for their potential application as optical biosensor in the research line of 'Tecnologías para la detección de biomarcadores' from EIA University. First of all the CDs were characterized by FTIR, DLS, ζ potential and fluorescence spectroscopy, then the CDs were conjugated with BSA (CDs-BSA) by adsorption and by the carbodiimide conjugation method, and at last CD-BSA fluorescence was quenched with GO (CDs-BSA-GO) and recovered with anti-BSA. The results obtained showed that GO (about 25 ppm) can quencher CDs-BSA (about 125 ppm) fluorescence by 45 %, in addition, it was found that anti-BSA (0.5 $\mu\text{g/mL}$) can recover CDs-BSA-GO fluorescence by 22 %.

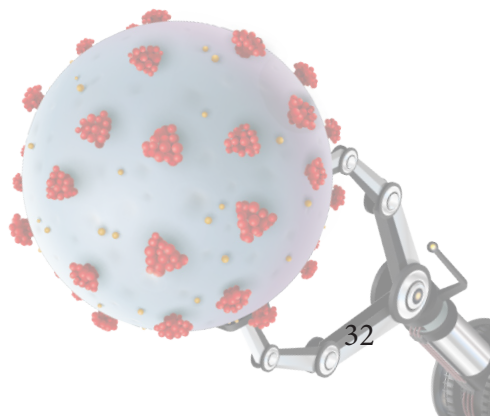
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Parametric study of thermal damage in the hyperthermia treatment by radiofrequency

Jorge I. Lopez and Leonardo A. Bermeo Varon

Radiofrequency (RF) hyperthermia therapy is a cancer treatment that consists of raising the temperature to induce thermal damage of the tumor tissues. The efficacy of this therapy depends on the frequency and power of the radiofrequency wave and the exposure time that defines the thermal dose that receives the tissues. Through mathematical models, it is possible to quantify the thermal dose caused by the hyperthermia process and to determine the degree to which it occurs. In this paper, a parametric study of the frequency, power, and exposure time of heat induction using RF hyperthermia is carried out. This study allows knowing if the damage caused is first-degree, second-degree, or third-degree burn. The results reveal that the three parameters are relevant to define an adequate treatment where the tissues do not reach a thermal dose above the second-degree burn.

ID: 53



UAOSIM-NIBP: An open-source, low-cost, blood pressure simulator

Julián Camilo Varela Guzman, Andres Mauricio Gonzalez-Vargas and Jhon Jairo Cabrera

Using simulators to generate physiological signals such as blood pressure allows a better understanding of the fundamental aspects of several biomedical instruments. In this paper, we discuss the design, implementation, and validation of an NIBP simulator. This simulator is low-cost and open-source, and has a graphical interface with valuable information that is not seen in most simulators. Therefore, it can be very useful for students of biomedical instrumentation. Given that these devices usually are expensive, it is difficult for academic institutions to have many of them, which can lead to a lack of availability of equipment during the course projects. Also, because the components are easy to find, inexpensive and all the instructions and schematics are available to share, every student could build their own simulator. We will present a summary of the design process and the system description as well as the validation tests and some conclusions.

ID: 62

Interactive mat for sensory and spatial development of children with visual or auditory disabilities

Sharon Lineth Corpus Mondragon, Juan Camilo Vergara Gil, Andres Mauricio Gonzalez-Vargas, Oscar Campo, Maria Camila Thorp Florez, Diana Isabel Alvear Hernandez, Mario Andres Gomez Rendon, Jeniffer Sinisterra and Andrés Darío Castillo

In the world, there are millions of children with severe visual or auditory disabilities, who face particular difficulties in the development of their spatial and sensory skills during the first years of their growth and their inclusion in school life. The development of rehabilitation devices adapted to a person's needs is an opportunity to improve the educational experience in biomedical design courses, and to work in collaboration with specialized institutions. In this article we present the design and development of an interactive mat for didactic purposes, which allows blind or deaf children to perform activities that improve their spatial capacity, has visual, sonorous and haptics features that promote their sensory development, and serve as a generalpurpose input peripheral for the computer, which makes it possible for children to interact through it with a lot of games and applications currently available.

ID: 63



Development of a Surface Electromyography Simulator to Evaluate Neuromusculoarticular Rehabilitation

Jairo Lenin Ramón Valencia and Ricardo Alonso Espinosa Medina

Virtual tools allow us to simulate surface electromyography signals (EMGs) in a pandemic period. In this study we propose the simulation of EMG signals and the design of a system for the acquisition, conditioning and visualization of muscle signals that can be used in muscle rehabilitation sessions. We perform an extraction of characteristics of an EMG signal, in the domain of time and frequency in relaxation events and voluntary contraction of a muscle. The relaxation and contraction signals were simulated using 21 harmonics (11 for the contraction state and 10 for the relaxation state). Then the signal was conditioned with operational amplifiers to be presented through a graphical interface by the Labview program, where the user will be able to see three (3) important components, amplitude and frequency parameter settings, EMGs graph and relaxation light indicators, a non-powerful contraction and muscle contraction.

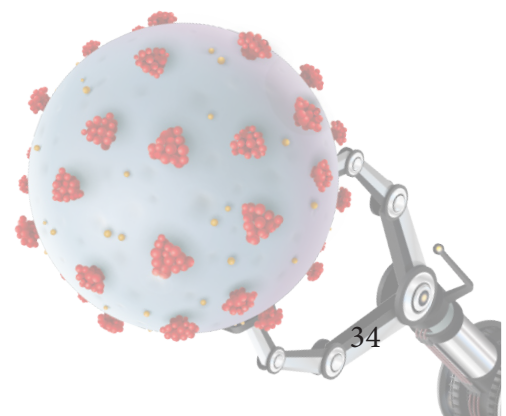
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Design and fabrication of a myoelectric prosthesis for trans-radial amputees

Fernando Luis Garcia Ayola, David Bigio and Mario Valderrama

Robotic prostheses for trans-radial amputees are expensive in Colombia and, as a result, most of the population in need can not afford one. We designed, built, and validated a myoelectric prosthesis for trans-radial amputee patients. To achieve this, we used an iterative methodology that started by identifying the needs of the users to then design, implement, and validate the product. The prosthesis was designed for a specific patient, with whom we worked together to determine the specifications. Consequently, each part was designed, developed, and tested. Finally, the parts were integrated and validated to produce the myoelectric hand prosthesis which solved the patient necessity.

ID: 67



Validation of an IoMT-based monitoring system for pressure ulcer prevention in a hospital environment: A pilot test.

Juan Manuel Puentes Sayo, Luisa Fernanda Cortes Torres, Pedro Antonio Aya Parra, Jefferson Sarmiento Rojas and Olga Lucia Cortés

Pressure ulcers are a significant public health problem that affects millions of patients worldwide since it compromises their health, decreases their quality of life, and can lead to permanent or partial disability and even death. Evaluate the correlation of the changes in patient position in bed from right lateral decubitus- to supine- to left lateral decubitus, captured by a new device developed by researchers, compared with a standard gold sensor. The validation and design of the functionality were supported by Internet of Things (IoT) technology to monitor immobile patients' positions hospitalized in intensive care. It was an observational study based on a sample of eight patients (2163 samples for characterization and 1318 samples to evaluate correlation). Changes of the position being censored by the new device were lateral right decubitus- supine- and lateral left decubitus. These measurements were compared with simultaneous observations of changes of position provided by an observer and a standard gold sensor. A linear correlation was verified between the measurements recorded by the two sensors for their axes (X, Y) of 0.98. The new device identified all the position changes performed on each patient, making an interface comprehensible for health-care providers. The system was evaluated as usable for their proposed applications. The angles detected by the device that were

developed are credited as valid, based on the linear correlation found. It was possible to obtain an indication of the precision of the degrees recorded by the developed device.

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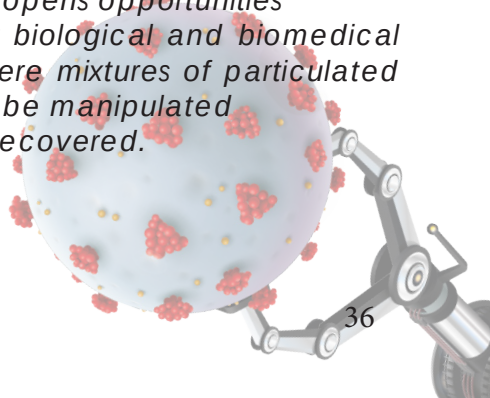
In silico Study and Characterization of an Asymmetric Pinched Flow Fractionation Microfluidic System for Spheroid Separation and Recovery

Saul Camilo Gómez, Andrés David Mantilla, Carlos Emilio Torres, Johann Faccelo Osma, Carolina Muñoz-Camargo and Juan Carlos Cruz

Microfluidics is an emerging research area that has acquired special interest in recent years due to the possibility to manufacture devices capable of outperforming traditional analytical and sensing instruments employed in biomedical and chemical research. For this reason, this approach has transformed research and development of various industries including medical, cosmetics, pharma, and food [1]. Thanks to the efficacy and the consistently decreasing cost over time of these devices, they have been widely explored for the synthesis, manipulation, and separation of microscopic encapsulates [2-4]. Within the biomedical field, this has led to important advances in the study and diagnostics of several conditions, including cancer and neurodegenerative diseases as it is possible to determine, for instance, cell heterogeneity in patient samples to detect abnormalities through cell separation devices [5]. Other applications have focused on the development of new in vivo testing methods to help reducing animal experimentation [6-8]. These applications have been enabled by microfluidics due to the possibility of controlling the overflow rates and interaction times between species within the devices. This study aims at developing a strategy to purify 3D cell aggregates resulting from the fusion of keratinocytes and fibroblasts, which will eventually be used for bioprinting 3D constructs with potential application in the production of dermo-epidermic skin equivalents. For this purpose, an Asymmetric Pinched Flow Fractionation

(AsPFF) system was studied in silico to estimate separation efficiencies based on parametric analysis of flow parameters such as Flow Rate Ratio (FRR) and Total Flow Rate (TFR). These analyses will be helpful for the isolation and separation of spheroids with a homogeneous average size distribution (i.e., 300 μm), which is important for a reproducible skin tissue model production. The geometry of the microdevice consists of 10 branches, 1 drain channel and a pinched segment of 800 μm width and it was created with the graphics interface of COMSOL Multiphysics® [9]. A Particle Tracing for Fluid Flow physics was implemented in a two-step study, stationary for the laminar flow fields and time-dependent to calculate the particle trajectories within the device. Combinations of FRR and TFR were evaluated for particles ranging from 20 to 500 μm , and the number of particles coming out the system through each output was counted to calculate the separation efficiency. In silico simulations results show high separation efficiencies and allowed us to estimate the size ranges obtained for each of the system outlets under the flow conditions established for the conducted parametric study. Likewise, our study confirmed the ability of the designed device to correctly separate and recover the 300 μm spheroids required for further applications in 3D bioprinting. Low-cost manufacture of the microfluidic device and in vitro experimentation will be carried out to compare the results of the computational simulations and to evaluate the device's ability to separate particles in a controlled laboratory environment. This will enable an evaluation of the device's efficiency in the purification of 3D cell aggregates. Moreover, it opens opportunities to enable other biological and biomedical applications where mixtures of particulated objects need to be manipulated and eventually recovered.

ID: 41



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Diseño de sistema de magnetoterapia con la finalidad de disminuir el dolor del síndrome patelofemoral

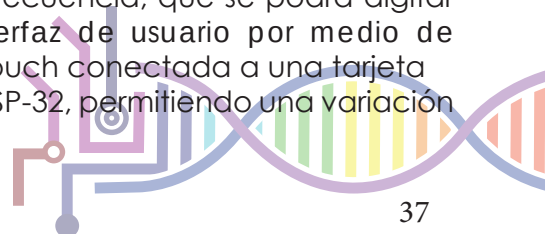
Sandy Tatiana Mesa Hincapie and Jhon Andres Gomez Portilla

Este trabajo tiene como objetivo diseñar un sistema de magnetoterapia con el fin de proporcionar analgesia a pacientes que poseen el síndrome del dolor patelofemoral (SDPF), el cual se puede definir como un trastorno doloroso en la cara anterior de la rodilla [1].

En la actualidad gran parte de los cirujanos ortopédicos coinciden en que los pacientes con SDPF, deben ser tratados por medio de tratamientos no quirúrgicos, ya que hay un escaso conocimiento en cuanto a este cuadro clínico; algunos de estos tratamientos hacen referencia a órtesis, fisioterapia, tratamientos farmacológicos, entre otros [2]. Es recomendable en la fase aguda de la patología realizar reposo con el fin de disminuir el dolor y desinflamar más rápido la zona afectada; para este reposo se recomienda usar terapias de analgesia como la crioterapia, TENS de alta frecuencia, magnetoterapia, entre otras [3].

La magnetoterapia es el método por medio del cual se aplican campos magnéticos constantes (CMC) o variables (CMV) con el fin de solucionar ciertas afecciones; en este caso van a ser usados campos constantes. A partir de varios estudios se ha comprobado el efecto sedante del campo magnético, especialmente en la musculatura [4]; los campos magnéticos comúnmente empleados para tratamientos médicos se pueden dividir en: variables y de baja intensidad y frecuencia [5].

A partir de lo anterior se identificó la necesidad de diseñar un sistema de magnetoterapia, el cual tiene como parámetro principal, el valor de la frecuencia, que se podrá digitar desde una interfaz de usuario por medio de una pantalla touch conectada a una tarjeta de desarrollo ESP-32, permitiendo una variación



entre 12Hz y máximo 50Hz. El campo magnético tendrá un valor de 75 Gauss, como consecuencia de la corriente que atraviesa la bobina, la cual corresponde a un valor de 4A. El diseño del circuito funciona con corriente directa y está dividido en dos etapas; La etapa de control (baja potencia) la cual a su vez esta subdividida en tres bloques, el primero describe el sistema por medio del cual se genera una señal cuadrada, el segundo bloque contiene un circuito inversor, en el cual un transistor trabaja en modo conmutación y el tercer bloque cuenta con un arreglo de resistencias en modo divisor de tensión con la finalidad de evitar el ruido. La segunda etapa del circuito incluye un par Darlington

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In silico Comparison Between Eulerian-Lagrangian and Eulerian-Eulerian Models for Size- and Density-based Separation: The Case of a Sedimentation Pinched Flow Fractionation System

Saul Camilo Gomez, Valentina Quezada, Isabella Quiroz, Luis Humberto Reyes, Johann F. Osma and Juan Carlos Cruz

Various multiphase flow models of computational fluid dynamics (CFD) techniques have been implemented in recent years to study the interactions of nano- and microfluid mixtures composed of particles suspended in a fluid due to their relevance in multiple processes such as liquid-based exchange [1], engine cooling [2], carbon dioxide absorption [3], drug delivery systems [1], mass transport [4], boiling phenomena and electronics [4]. Models involving two-phase approaches consider the base fluid and the particles suspended in the mixture independently and with different velocities so that the particles move relative to the base fluid [1]. Also, they can be classified into two main groups: (1) Eulerian-Eulerian and (2) Eulerian-Lagrangian models, which differ in whether the phases are considered continuum or discrete [2]. In this regard, Eulerian-Eulerian models categorize the base fluid and the nano- or micro-particles phases as a continuum, while in Eulerian-Lagrangian models the base fluid is continuum and the nano- or microparticles are referred to as a discrete phase [2]. Importantly, the Eulerian-Lagrangian approach provides more accurate results at the expense of higher computational costs due to the large number of individual entities required to model the particles, and the small value of Stokes number for the particle's flows [1, 3]. In this approach, the particle motion is modeled by a Lagrangian reference frame, which tracks the trajectory of suspended particles along with the fluid flow [3, 4]. In contrast, Eulerian-Eulerian models cannot track the position of individual particles but instead groups of them, which is closer to real physical situations in biological contexts [1, 4].

This study aims to compare the Eulerian-Lagrangian and Eulerian-Eulerian approaches in the multiphysics simulation of polymeric microparticles separation via a Sedimentation Pinched Flow Fractionation (PFF) system proposed by Morijiri et al. [5]. Moreover, particle size, particle density, and particle loading will be considered for the comparison between the different multiphysics approaches. Mixture Model (MM), Euler-Euler (EE), and Particle Tracing for Fluid Flow (PT) physics were implemented in COMSOL Multiphysics® under the same flow conditions, where a suspension of microparticles with diameters in the range between 10 - 100 μm was injected into the system to verify the sedimentation principle put forward by Morijiri et al. experimentally [5]. Although MM and EE approaches showed similar results, the EE model led to more accurate density-based particle separation results compared to the MM and PT models, which failed to distinguish between particles of different densities. Furthermore, the PT model showed a precise size-based separation where particles of the same size exited through the same outlet channel. In contrast, in the EE and MM models, mixed particles exited through different outlets. These preliminary results indicate that in a realistic experimental scenario, the system separation performance might be below the expectations and therefore there will be still room for improvement through geometric and operation changes such as pinched segment width adjustment, modifications of the angle and curvature radius in post-pinched segment expansion, and parameterization of the ratios between inlets' flow.

ID: 47

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lerian method: A review.", *International Journal of Chemical Reactor Engineering*, vol. 17, no 11, 2019. [6] M. Wörner, "A compact introduction to the numerical modeling of multiphase flows.", FZKA, Vol. 6932, 2003. [7] Y. Yan, X. Li, K. Ito, "Numerical investigation of indoor particulate contaminant transport using the Eulerian-Eulerian and Eulerian-Lagrangian two-phase flow models.", *Experimental and computational multiphase flow*, vol. 2, no 1, pp. 31-40, 2020. [8] T. Morijiri, S. Sunahiro, M. Senaha, M. Yamada, and M. Seki, "Sedimentation pinched-flow fractionation for size- and density-based particle sorting in microchannels," *Microfluid. Nanofluidics*, vol. 11, no. 1, pp. 105–110, 2011, doi: 10.1007/s10404-011-0785-6.



Mathematical Model from Multiple Linear Regression for Hyperthermia Therapy with Heating Induced by Laser

Santiago Amado, Daniel Mauricio Valdes, Leonardo A. Bermeo Varon and Nilton Pereira da Silva

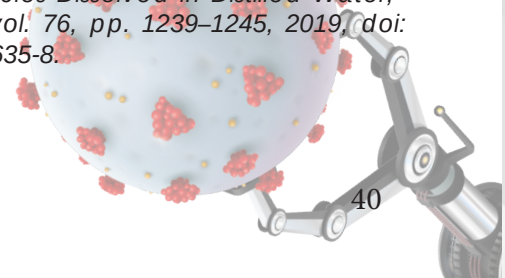
Currently, there is interest in the study of hyperthermia therapy for cancer treatment. This therapy consists of increasing the body temperature to between 37° C to 43° C, which is performed by inducing electromagnetic waves through radiofrequency waves, microwaves or/and laser, and ultrasound waves as alternative methods for treatment [1]–[7]. Additionally, the use of nanoparticles loaded in the tumor allows a focused treatment [8], [9], thus obtaining limited side effects and reducing damage to surrounding healthy tissues. For the implementation of this treatment, it is necessary to perform in vitro experiments and simulations of mathematical models that allow obtaining a better knowledge of the therapy. However, current models are complex, and in many cases, require a high computational cost. In this sense, this work proposes a model with a low computational run-time through the multiple linear regression technique. A total of 200 datasets were obtained by Comsol Multiphysics on 10 mL of fluid maintained in Petry plates, with a radius of 28 mm and height of 13.4 mm. 80% of the data were used for training the regression model and the remaining 20% for validation. The input data were the model parameters, and the output data were the temperature field. The experimental measurements were taken by an infrared camera and heated by a laser diode at a current of 2200 mA, corresponding to a heating power of 0.327 W in the near-infrared range during 100s on pure distilled water and two different proportions of iron oxide nanoparticles dissolved in distilled water. i.e., 0.025 wt% and 0.050 wt% [10]. The results indicate that the temperature field predicted by the multiple linear regression model was very close to the output values of the mathematical model and measurements. i.e., the correlation of the multiple linear regression model was 0.99 with respect to the model performed with Com-

sol Multiphysics. Concerning to experiment the correlation was 0.95. These values show the high efficiency of the model proposed in this study. Also, the model presents a considerable reduction of computational run-time. The prediction of the multiple linear regression model was 1.94 ms compared with the model of Comsol Multiphysics that was 25.29 minutes. This reduction of the computational run-time will allow the planning of the hyperthermia therapy before and during its implementation.

ID: 61

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2^{do} CONGRESO INTERNACIONAL
DE INGENIERÍA BIOMÉDICA Y
BIOINGENIERÍA (CI-IB&BI 2021)



Biomateriales

Chitosan/Glucantime Hydrogels as a Treatment for Cutaneous Leishmaniasis and its Preparation Method: Systematic Review

Karen Tatiana Valencia Rivero, Daniela Hernández, Paola Sánchez and Fernanda Rincón

The best method for the preparation of Chitosan/Glucantime hydrogels as an administrative mechanism for the treatment of Cutaneous Leishmaniasis was identified through the systematic review of sixteen scientific articles selected by a rigorous methodology based on the PRISMA protocol that was divided into six phases: Determining eligibility criteria, search strategy, selection of articles, MMAT quality evaluation, information synthesis, and bias evaluation. After literature review, it was determined a protocol for the preparation of hydrogels that proposes to use chitosan as a biopolymer, cuminaldehyde as a crosslinking agent, and Gellan Gum spheres for Glucantime loading. This protocol provides a promising treatment for patients with cutaneous Leishmaniasis using biomaterials as drug delivery devices, contributing to the medical and biomedical fields.

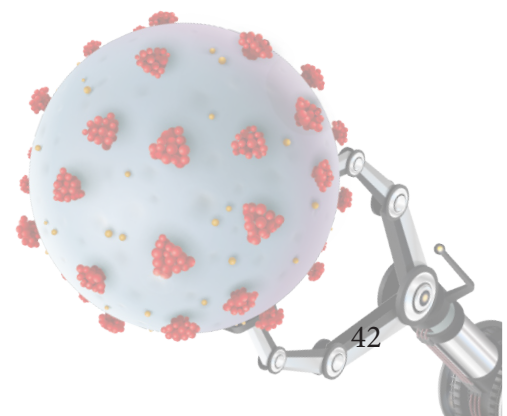
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Characterization of a polymeric composite material for its potential use in the replacement of anterior cruciate ligament

Maria Alejandra Ramírez-Torres, Andrés Felipe Zemanate L., Paola Andrea Neuta A. and Julio César Caicedo

The purpose of this study was to develop a polymeric composite material that could be considered in the future for its use in the manufacture of an artificial graft to the replacement of the ACL. The synthesized material is composed of a matrix of polylactic acid (PLA), and multiwalled carbon nanotubes (MWCNT) functionalized with polycaprolactone (PCL) as reinforcement. The composite material was characterized chemically and biologically.

ID: 27



Potential Bone Fillers Based on Composites of Cocoa Bean Shells and Poly(Lactic Acid): Compression Molding Manufacturing

Andres J. Garcia-Brand, Alejandro Maranon, Carolina Muñoz-Camargo, Juan C. Cruz and Alicia Porras

Biodegradable polymers have attracted significant attention for their highly versatile processing and manufacturing alternatives for bone filling applications. However, several issues regarding mechanical performance are yet to be solved prior to allowing maximal loading transfer between adjacent tissue and the implanted biomaterial. An issue that could be overcome by fine tuning their mechanical stiffness through incorporation of natural lignocellulosic fibers such as cocoa bean shells (CBS). Hence, this study presents the fabrication by compression molding of Poly(lactic acid) (PLA) and CBS composites for their potential use as bone fillers. The obtained materials were characterized in terms of mechanical performance and cytotoxicity in vitro. The PLA/CBS composites showed an increase in stiffness as a function of the CBS content. However, no statistically significant changes ($p < 0.05$) were observed for the three-point bending flexural properties of composites with CBS content below 10%wt. In addition, the cell viability of Vero cells in the presence of the composites was above 94% after 24 h, demonstrating potential in vitro biocompatibility. The obtained results indicate that a suitable route was developed for manufacturing filled biocompatible composites with tunable mechanical properties comparable to those reported previously for bone fillers

ID: 64

Chitosan methacrylate-based bioadhesive: towards a photoresponsive and extrudable material for bone fracture repair

Daniela N. Céspedes-Valenzuela, Santiago Sánchez-Rentería, Carolina Muñoz-Camargo and Juan C. Cruz

The development of biocompatible and easy to apply bone adhesives with significant adhesion performance under typical physiological conditions is currently considered one of the main challenges in bone tissue repair. Currently, commercially available materials, such as polymethylmethacrylate, fail to provide sufficient biocompatibility on the surroundings of the fracture, which in turn largely limits tissue repair. Chitosan, a widely studied natural polysaccharide, not only presents desirable biocompatibility, but also promising adhesive properties. Consequently, here we aimed to develop a chitosan-based bioadhesive with superior adhesiveness and enhanced biocompatibility. This was achieved by the chemical modification of chitosan's main backbone with methacryloyl groups that provide photoresponsiveness to tune the hydrogel's crosslinking level and consequently, mechanical properties.

ID: 38



Evaluation of polymeric biomaterial as an option for tissue replacement in plantar calcaneonavicular ligament injuries

Sebastian Nieto, Christian Javier Cifuentes and Juan Carlos Cruz

Spring ligament is a structure responsible for giving stability to the plantar arch of the foot. Some injuries or rupture of this ligament can have consequences such as flat feet or induce the foot to have greater ranges of motion of pronation and abduction. The solutions proposed over time have been to reconstruct the ligament through autograft or allograft surgery, however, research and results have shown that this is a temporary, partial solution, or even a new way to worsen the previous problem. In this research, new tissue engineering technologies will be used to obtain a Scaffold from synthetic and natural polymers that give the new ligament mechanical and biological properties, respectively, to obtain a tissue as close to the native one. A solution of 50% PCL- 50% type II collagen, at a concentration of 10%w/v, was prepared. The solution was electrospun under an align fibers configuration. The sample obtained was characterized in a uniaxial equipment obtaining values of: Ultimate tensile stress = 1.375MPa; Young's modulus = 7.767MPa; Poisson's ratio = 0.1. These mechanical properties were attached to a healthy foot model provided by [2], to evaluate the performance of the new SL properties versus the healthy model. The tissues primarily involved in plantar arch stabilizers: FP, LPL and SPL, were evaluated. Due to the elastic properties of the material, the computational model of the foot, presented high loads on the mentioned tissues, also displacements that discrepancy from the healthy ones. The electrospun scaffold does not yet meet the specifications to act as a possible graft with successful mechanical properties that would allow the spring ligament to withstand the loads without foot collapse or excessive pronation.

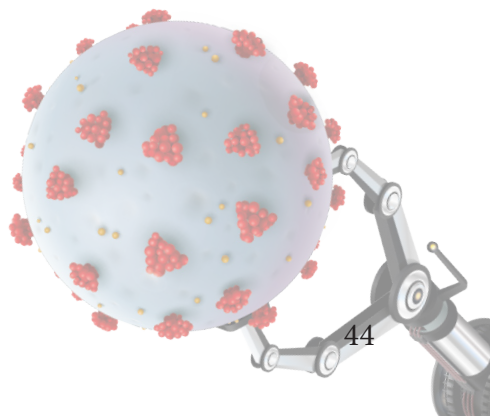
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Conjugation evaluation of African oil palm biochar derived Carbon Dots with anti-BSA

Juan Pablo Arango, Maria Isabel Gaviria, Kaory Barrientos, Marisol Jaramillo and Pedronel Araque

The present study synthesized Carbon Dots (CDots) obtained from *Elaeis guineensis* biochar and then conjugated it with a model molecule, in this case, an antibody of Bovine albumin serum (Anti-BSA). The CDots had a size of 2.5 ± 0.7 nm determined through a High-Resolution Transmission Electronical Microscopy (HR-TEM), a Z potential of -56.1 ± 2.37 mV and a Quantum yield of 1.69%, with emission and excitation wavelengths of 428 and 320 nm, respectively. As a bioreceptor molecule, the anti-BSA conjugated to the CDots surface using the carbodiimide method. With the implementation of this technology, it will contribute to the improvement of the quality of life of Colombian vulnerable populations while contributing to the closing of cycles of the oil palm industry by implementing it in the development of optical biosensors for the detection of different health biomarkers like TB antibodies or pesticides in water.

ID: 68



Bio-molecular interactions: blood components, cells and biomaterials in the regeneration of acellular vascular grafts

Maria A. Rodriguez-Soto, Natalia A. Suárez, Alejandra Riveros, Andres J. Garcia-Brand, Carolina Muñoz-Camargo, Juan C. Cruz and Juan C. Briceño

Cardiovascular disease is the leading cause of death worldwide, the requirement of vascular grafts, intended to replace the function of a blood vessel remains of main importance. Available vascular grafts in the market are not successful in some conditions. One of the failure causes for synthetic vascular grafts is the patency loss that occurs as a result of an alteration of the physiological behavior of the cells and blood components in the vascular tissue when in operation conditions. Even when the tissue engineering and regenerative medicine fields have proposed strategies to overcome these limitations, the design of regenerative vascular grafts is challenging given that they must promote and properly guide tissue regeneration. In consequence, this work aims for the analysis and evaluation of the bio-molecular interactions between the blood components, cells and biomaterials that have been reported during the regeneration of vascular useful for rational design of vascular grafts.

ID: 88

Mechanical characterization of novel vascular grafts: approaching to the native vessel behavior

Maria A. Rodriguez-Soto, Natalia A. Suárez, Alejandra Riveros, Andres J. Garcia-Brand, Juan C. Cruz, Carolina Muñoz and Juan Carlos Briceno

Cardiovascular disease is the leading cause of death worldwide, the requirement of vascular grafts, intended to replace the function of a blood vessel remains of main importance. Available vascular grafts in the market are not successful in some conditions. One of the failure causes for synthetic vascular grafts is the patency loss that occurs as a result of an alteration of the physiological behavior of the cells and blood components in the vascular tissue when in operation conditions. Even when the tissue engineering and regenerative medicine fields have proposed strategies to overcome these limitations, the design of regenerative vascular grafts is challenging given that they must promote and properly guide tissue regeneration. In consequence, this work aims for the analysis and evaluation of the bio-molecular interactions between the blood components, cells and biomaterials that have been reported during the regeneration of vascular useful for rational design of vascular grafts.

ID: 90



Resveratrol/Ro5-3335 Nanoemulsion for Potential Application in Retinal Drug Delivery

Sarah De Los Rios, Juliana Gonzalez, Marybel Montoya, Pedronel Araque and Martha Londoño

Proliferative Diabetic Retinopathy (PDR) can form fragile neovessels enhancing the risk of bleeding and increasing intraocular pressure. It is necessary to develop new treatments based on nanoemulsions administered ophthalmologically, that could reach specific sites desired and have minimally invasive drug release for the patient. In this study, Resveratrol/Ro5-3335 nanoemulsions (RSV-Ro5 NEs) stabilized with polyvinyl alcohol (PVA) were synthesized by the phase inversion method, both active principles have never been combined before in previous investigations. The physicochemical characterization of the nanoemulsion was examined for Droplet Size using Dynamic Light Scattering (DLS) and Nanoparticle Tracking Analysis (NTA), Droplet Morphology using Transmission Electron Microscopy (TEM), and Fourier Transform Infra-red spectroscopy analysis (FTIR). By controlling variables such as the molecular weight of the polymer, stirring, dripping, and temperature, stable-in-time spherical nanodroplets were obtained with an average of less than 500 nm. The above drugs can modulate retinal inflammation and inhibit or prevent the formation of abnormal blood vessels. The data reported in this work suggest the potential of these formulations in future treatments to control pathological ocular angiogenesis diseases.

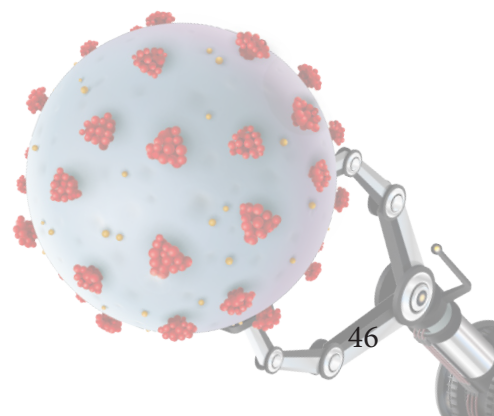
ID: 98

Estimation of stress and strains on the supraspinatus tendon based on humerus and scapular bones effects: An approach by Computer and Experimental Models

J. C. Briceño, G. A. Espinosa, J. C. González, F. Ramirez, and D. M. Sanchez

Estimation of stress and strains on the supraspinatus tendon based on humerus and scapular bones effects: An approach by Computer and Experimental Models. The present purpose of this study - project was to integrate computer assisted analysis, mechanical experimentation, and clinical studies to develop a tool or quantitative criterion for the diagnosis, treatment and rehabilitation of the upper limb of patients with rotator cuff tears. The data based of the models use codes of Python, Matlab Academic, and C+. It was observed that the join of the osteocyte bones cells and tendons cells are stiff to analyze, and segment; but is the relevant interface region related with the disease of general biological bones tissues."

ID: 114



Diseño de una tinta de biomaterial para la bioimpresión tridimensional a partir de alginato funcionalizado con plasma rico en plaquetas con potencial uso para el tratamiento de la osteoartritis

Silvia C Suarez-Mantilla, Karen S Vega-Bautista, Silvia M Becerra-Bayona and Victor A Solarte-David

La osteoartritis (OA) es una enfermedad reumática que afecta el cartílago y los huesos de las articulaciones, disminuyendo significativamente la calidad de vida de los afectados, además es de alta prevalencia en la población colombiana. Su tratamiento se centra en analgésicos y antiinflamatorios, brindando una solución a corto y mediano plazo, lo que genera la necesidad de desarrollar nuevas alternativas terapéuticas [1]. Entre las alternativas encontramos la inducción de procesos regenerativos con factores de crecimiento, los cuales pueden inmovilizarse en matrices para lograr una liberación controlada. Adicionalmente, es posible diseñar estas matrices de manera personalizada mediante la implementación de la impresión 3D, lo que permite una implantación de la matriz acorde a las necesidades tridimensionales del tejido [2]. En este contexto, este proyecto de investigación tuvo como objetivo el desarrollo de una tinta de biomaterial para la bioimpresión tridimensional de una matriz de alginato de sodio, funcionalizada con plasma rico en plaquetas (PRP) [3, 4]. Para esto se prepararon soluciones con diferentes concentraciones de alginato de sodio (1%, 2%, 3% y 4% p/v), y se pre-reticularon físicamente con CaCl_2 , posteriormente se imprimie-

ron diferentes estructuras en 3D (Filamento, rejilla, disco y aros) y se calculó la imprimibilidad, analizando así la fiabilidad de la bioimpresión, seleccionando así la mejor concentración de alginato (3% p/v), bajo los mejores parámetros de impresión. Consecuentemente, se llevó a cabo la preparación de la tinta de biomaterial de alginato de sodio funcionalizada con PRP, y se evaluó su imprimibilidad, además de la capacidad de hinchamiento de las estructuras impresas, propiedades mecánicas y la cuantificación de proteínas inmovilizadas en las estructuras 3D. Los resultados muestran que es posible el desarrollo de una tinta de biomaterial a base de alginato y PRP; no obstante, aun requiere un protocolo de prereticulación eficiente, dado que pueden presentarse precipitaciones que no permiten la homogeneidad en la tinta de biomaterial.

ID: 35



Analysis of the Effect of Piezoelectricity in the Manufacture of Polymeric Films with Potential Use in Cellular Osteogenesis - Systematic Review

Karen Tatiana Valencia Rivero and Juliana Villegas

Attachment of the material to an electromagnetic load stimulate growth and differentiation of bone tissue, reason why biomaterials with piezoelectric properties are important to be studied. Extracellular matrix (ECM) present in bones has two components, an organic component that contains type I collagen, responsible for the flexibility of bone, and an inorganic component with piezoelectric components called hydroxyapatite (HA). HA generates electric dipoles attracting osteoblasts, cells responsible for bone regeneration, generating a deposit of calcium and minerals that promote bone regeneration [1]. An insufficient osteoconductivity can be a problem that limits cell proliferation in bone repair, therefore this factor needs to be deeply analyzed [2]. Knowing a value called piezoelectric coefficient d_{33} , which can be measured by various methods such as piezo-response force microscopy (PFM), it is expected to have better results in bone regeneration, since in biomaterials with values of 9.24 pC / N , close to the constant present in bone, stability is close to the 90% of the original piezoelectric coefficient, thus concluding that by varying or having a close piezoelectric coefficient (9.24 pC / N), bone regeneration can be improved through the GBR method [2]. This research aims to carry out a systematic review through the MMAT matrix and the PRISMA methodology to analyze the effect of piezoelectricity in the manufacture of polymeric films with potential in cellular osteogenesis [3]. Selection of three databases was made: Pubmed, ScienceDirect, and Web of Science. Final operator used was ((Guide bone regeneration*Osteogenesis*) AND (piezoelectric bone response OF piezoelectric properties*) AND (piezoelectric biopolymer-

s*ORpiezoelectriccoefficients*) AND (Poly(vinyl alcohol) OR Poly(vinylpyrrolidone OR(nanogenerator) NOT (nanogenerator *)), obtaining a total of 557 articles. Data collection was carried out in the free Rayyan software. Total number of articles included after Rayyan analysis was 33, and a final filter was made following the MMAT matrix to finally select 18. Materials most used in research on the relationship between bone regeneration and piezoelectricity are poly(vinylidene-trifluoro ethylene fluoride) - (P(VDF-TrFE)), Barium titanate (BaTiO_3), Polyvinyl alcohol (PVA), Polyvinylpyrrolidone (PVP), Hydroxyapatite-HA, Polycaprolactone (PCL), Polyvinyl alcohol (PVA), and Polyvinylpyrrolidone (PVP). It is necessary to evaluate in each material or combination of the materials mentioned, mechanical resistance, surface texture, flexibility, compatibility, piezoelectricity, conductivity, and cellular osteogenesis [4], [5]. According to the data obtained in this research, the polymeric film manufacturing technique most currently used is electrospinning, with 94% of use, while solvent casting has the remaining 6%. Difference between these two methods is that the scaffold generated by electrospinning provides a high surface/volume ratio that benefits the release of drugs with high porosity and permeability, while the materials made by solvent casting are based on economic advantages, repeatability, and ease to manufacture [5], [6]. It was found that the best materials to use for the creation of polymeric films for bone regeneration are HA and PVA since they obtain average piezoelectric results of $9,305 \text{ pC / N}$ close to bone, supported by 47% of articles reviewed. Electrospinning as a manufacturing method and the use of the piezoelectric response microscope as a characterization method are the best selection techniques due to their good results, having an appearance in articles and effectiveness of 94% and 17%, respectively [10]. For future works, it is recommended to further explore mixtures between PVA, PVP, HA and CS, given the regenerative properties of these biomaterials and its low piezoelectric characterization when combined. Currently, these materials provide great physical and piezoelectric characteristics individually. A potential scaffold obtained by the mixture of these materials may improve bone regeneration with a proper regulation of density, porosity, HA or CS content, and supplied voltage

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Caracterización mecánica de hidrogeles de fibrina partir de plasma rico en plaquetas con potencial uso en el diseño de matrices biomiméticas

Freddy A. Sierra-Sanchez, Carlos D. Brito-Lizarazo, Silvia M. Becerra-Bayona and Victor A. Solarte-David

Los hidrogeles de fibrina obtenidos a partir de plasma rico en plaquetas (PRP) han despertado gran interés en los últimos años, ya que han demostrado resultados favorables en la ingeniería de tejidos, debido a su alto contenido de factores de crecimiento, que promueven la proliferación celular y sus redes de fibrina que le brindan soporte estructural al hidrogel, así como la posibilidad de permitir la fabricación de andamios naturales, similares a las matrices extracelulares, idóneos para la regeneración tisular. Sin embargo, sus características mecánicas no han sido caracterizadas plenamente, lo que puede representar un obstáculo para el uso de este material como andamio para la regeneración de un tejido en específico. Por esta razón, en este estudio se fabricó hidrogeles de fibrina a partir de PRP, bajo diferentes parámetros de concentración de PRP y tiempos de gelación del hidrogel, con el fin de realizar pruebas de compresión, y documentar sus características mecánicas. Se fabricaron hidrogeles con tres concentraciones, la metodología estándar para fabricar PRP que según la literatura es como se obtiene mayor cantidad de plaquetas, se denominó "concentración 100%", se basa en separar el plasma de la sangre, para extraer las plaquetas del plasma y finalmente agregar una pequeña cantidad de plasma a las plaquetas extraídas, con base a ésta, se fabricó a una menor concentración de PRP al diluirlo con PBS, se denominó "75%", la tercera con un 33% más de concentración al haber disminuido la solución de plasma, se denominó como "133%"; asimismo, se variaron los tiempos de gelación para cada concentración de hidrogel, 2, 4 y 24 horas. Como resultado se evidenció que los módulos de elasticidad de los hidrogeles varían entre 2 kPa y 35 kPa, resultados que pueden ser comparados con

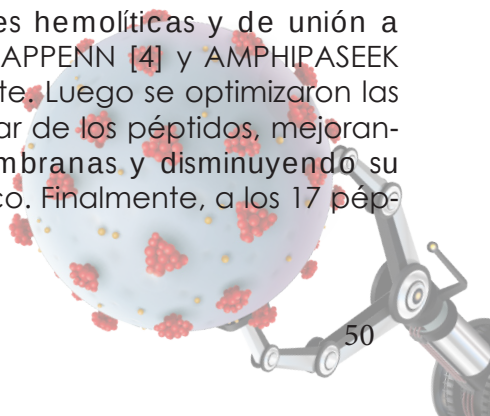
los de autores como Sadeghi-Ataabadi, et al, (2017), que variaron la concentración de calcio y obtuvieron módulos entre 44 kPa y 53 kPa, o Murphy, et al, (2017) que diseñaron la fibrina con células madre y obtuvieron módulos entre 0.2 kPa y 80 kPa, de esta forma se corrobora que hay similitud en los rangos de los módulos obtenidos. También, se puede proponer estudios relacionados a la regeneración de tejidos como la córnea que tiene entre 0.3 kPa y 4.3 kPa o el ligamento periodontal que varía entre 40 kPa y 160 kPa. Adicionalmente, se determinó que los hidrogeles de PRP tienen una relación de hinchamiento de 6 a 32 veces su peso seco, una relación de re-hinchamiento entre 3.5 y 7.2 veces su peso seco, y una tasa de degradación entre 14% y 47% por hora. Este estudio permite tener un punto de partida para adecuar los hidrogeles de PRP según el uso que se busque en el área de ingeniería de tejidos, con el fin de obtener hidrogeles biomiméticos al ajustar sus propiedades mecánicas a las que presentan los tejidos a regenerar.

ID: 36

Identificación y optimización in silico de péptidos antimicrobianos cortos con potencial terapéutico

Dahiana Elizabeth Monsalve García, Sergio Orduz Peralta, Carlos Andrés Mera Banguero and John William Branch Bedoya

La resistencia a los antibióticos es un problema de salud pública mundial. A esto se suma el bajo interés de la industria farmacéutica en el desarrollo de nuevos antibióticos, sobre todo por el bajo retorno de la inversión que estos representan cuando se usan los modelos tradicionales de bioprospección. En los últimos años, como alternativa para el desarrollo de nuevos medicamentos, se han empezado a utilizar unas moléculas del sistema inmune llamadas péptidos antimicrobianos (AMPs). El interés en estas moléculas está en su capacidad de interactuar con las membranas de las bacterias. Con el propósito de identificar nuevos AMPs potenciales in silico, en este estudio se analizaron los proteomas de ocho organismos y se identificaron y optimizaron 17 péptidos con base en las características específicas que debe tener un AMP. La metodología que se empleó es la siguiente. Se utilizó PepMultiFinder 2.0 [1] para analizar 150450 proteínas contenidas en ocho proteomas. Esta herramienta permitió identificar 513909 péptidos cortos con características fisicoquímicas compatibles con los AMPs naturales. Los péptidos identificados se filtraron con tres predictores de AMPs [1] usando un umbral de clasificación ≥ 0.98 . Sólo 17 péptidos pasaron este filtro. Después, se modificó la secuencia de los péptidos obtenidos con Type-Peptide 1.0 [2] y HeliQuest [3] buscando que hubiera una clara separación de las caras polares y apolares. Posteriormente, se evaluaron las propiedades hemolíticas y de unión a membranas con HAPPENN [4] y AMPHIPASEEK [5], respectivamente. Luego se optimizaron las caras polar y apolar de los péptidos, mejorando la unión a membranas y disminuyendo su potencial hemolítico. Finalmente, a los 17 pép-



tidos se les calculó su estructura 3D [6], puesto que todos mostraron tener una alta probabilidad de ser AMPs. Como conclusión se observó una relación directa entre la separación de las caras polar y apolar en una rueda helicoidal con la unión a membranas. Entre más están definidas las caras, mayor es la probabilidad de unión a membrana, según AMPHIPASEEK [5]. Finalmente, se evidenció que la metodología empleada permite identificar y mejorar la capacidad antimicrobiana de péptidos in silico, los cuales pueden tener una alta probabilidad de funcionar en ensayos in vivo.

ID: 37

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Diabetic Foot Ulcers Healing with Biomaterials: a Bibliographic Review Oriented to Chitosan Synthesized with Mimosa Teuiflora Cortex.

Karen Tatiana Valencia Rivero, Juan D. Umaña, Luz Ángela Paipilla, Valeria Ramírez and Juan Salamanca

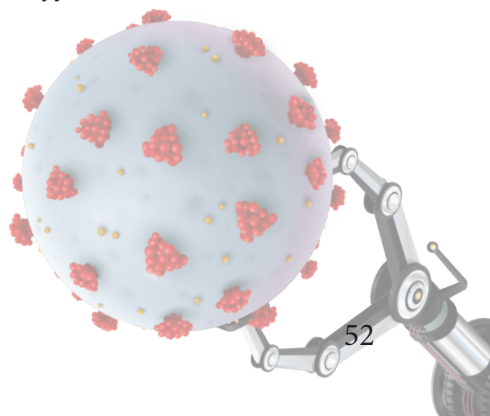
Natural polymers have gained attention in the treatment for skin wounds and one of the most used natural polymers, Chitosan is remarkable. Chitosan is obtained from chitin through a chemical process of N-deacetylation [1]. Chitosan has physicochemical properties like biodegradability, biocompatibility, non-toxic, and antiviral [2], making this material a candidate for medical applications as drug release and burns treatment by improving cell function [3]. Chitosan has been mixed with several polymers to improve regenerative properties, and in this study, mixture with Mimosa teuiflora (MT) wants to be analyzed. MT is a native plant from Mexico, used in pre-Hispanic times to cure skin diseases and as a cell regenerator [4]. Its traditional use is based on infusions to wash skin wounds, powder, or cream for the treatment of burns, reducing pain and risk of infection [5]. The purpose of this study was to prepare a bibliographic review to identify the influence of biomaterials on diabetic foot ulcers healing, specifically those made with Chitosan synthesized with MT. Studies related to MT are mainly from Mexico and have been developed from 2007 to 2019. Articles that were developed in Spain, Korea and Germania acquired the MT from Mexico. Results showed that properties of MT for wound healing are due to saponins, tannins, glycoproteins, arabinogalactans and mimonosid saponin triterpenes present in its composition, and due to chemical groups or bonds as hydroxides, amines, carbonyls, amides, carbon-oxygen, and ether groups. Synthesis of Chitosan and MT was found in the literature presenting an optimal regenerative material for tissue healing. According to the results obtained in [6], [7] and [8] addition of MT to Chitosan provides stability and improves regenerative properties. In [7] it was also identified that morphological and spectrophotometric characterization of the films suggests a good dispersion of MT powder in the film and a suitable thickness for use as

dressings was obtained. Additionally, [9] and [10] reported that MT has poor mechanical properties, but good cytotoxic properties. In articles [6], [7], [11] and [12] it was found that in fibroblasts, mononuclear cells and osteoblasts, good viability and cell proliferation were obtained. In [7] was reported In the analysis of enzymatic degradation, 90/10, 80/20, and 70/30 chitosan/MT powdered are more susceptible to the hydrolytic action of lysozyme enzyme, and about the antimicrobial activity it was found that the composites made of 70/30 chitosan/MT have high activity against gram-negative (24% after 24 h), but higher against gram-positive bacteria (95% after 24 h), the synergistic effect on this property is due to the presence of antimicrobial substances such as tannins, saponin and phenolic compounds. A pH of 6.9 - 7.2 is also reported. Swelling or absorption capacity of Chitosan increased with the addition of MT, due to the intermolecular interactions of the amino groups (NH₂) in chitosan, and hydrophilic groups (OH) of the phenolic compounds of MT [6] [7]. While MT concentration increases, number of hydrophilic groups present in chitosan decreases, reducing the compound's ability to absorb water [6]. In [6], a high absorption capacity of hydrogels made up with Chitosan and MT, presented good solubility and degradation, additionally none of the samples were cytotoxic for mononuclear cells. Studies showed that cytotoxicity evaluated through L-929 and 3T3 cell lines was low due to an 80%-100% cell viability. In general, literature suggest that combination of Chitosan with MT could become a potential application for tissue regeneration and potential use of Chitosan and MT for wounds healing applications, and specifically for diabetic ulcers was demonstrated through results obtained in different studies found in this literature review. Researchers established effectiveness and safety of the compounds through healing, infection, and inflammation processes of the wound. At appropriate concentrations, compounds did not present adverse reactions or events, but presented antibacterial, antioxidant and anti-inflammatory effects ideal for this application.

ID: 55

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Respuesta Fluorescente de Puntos de Carbono Dispersos en Solución Acuosa de L-Lactato

Jessica D. Sánchez Fonseca, Alvaro D. Orjuela Cañón and Diana C. Rodríguez Burbano

Los puntos de carbono (PC) son nanopartículas fluorescentes compuestas en su mayoría por carbono con hibridación sp^2 . La emergente atracción generada por estas nanopartículas se debe a su estabilidad coloidal en soluciones acuosas, biocompatibilidad y sus propiedades ópticas [1]. Los PC tienen la propiedad de generar fluorescencia en el espectro visible al ser irradiados con luz UV-Vis. Estas propiedades los han hecho candidatos para ser usados en el desarrollo y mejoramiento de diferentes aplicaciones biomédicas, tales como agentes contrastes para técnicas de adquisición de imágenes, plataformas teragnósticas, de liberación de medicamentos y biosensores. Un analito de interés, para su detección por medio de fluorescencia, es el L-lactato. Ya que la determinación de su presencia y concentración pueden proveer información útil para el diagnóstico clínico y el seguimiento a deportistas de alto rendimiento [2]. Actualmente, la medición de este analito puede realizarse a través de sensores basados en sistemas electroquímicos o por medio de pruebas en laboratorio, demandando un alto costo económico y medio ambiental. Además, infraestructura robusta con equipos especializados en laboratorio y talento humano son necesarios para el manejo de muestras e interpretación de resultados. Es así como el uso de fluorescencia de los PC para la detección de L-lactato ofrece ventajas, como resultados analíticos mediante lectura visual directa, y mejorar la precisión y sensibilidad con bajos límites de detección [3]. Adicionalmente los PC ofrecen propiedades que incluyen fotoestabilidad, ausencia de fotoblanqueo y buena fotoluminiscencia [4]. El objetivo de la presente investigación consiste en desarrollar una variación en la respuesta fluorescente de los PC dependiente de la concentración de L-lactato presente en una muestra acuosa. La síntesis de estas nanopartículas se realizó por el método solvotermal a una temperatura de

160°C por 12 horas, usando como precursores orgánicos ácido cítrico y urea y como solvente formamida. Las propiedades de absorción de los PC obtenidos fueron caracterizadas por espectrometría UV-Vis, donde se evidencian bandas de absorción entre los 220 y 250 nm y 320 y 370 nm, atribuidas a transiciones electrónicas $\pi \rightarrow \pi^*$ relacionadas al enlace C=C, y las transiciones $n \rightarrow \pi^*$ relacionadas a los grupos funcionales basados en nitrógeno, respectivamente. Por otro lado, el espectro de emisión evidencia bandas fluorescentes entre los 420 y 470 nm con una excitación a una longitud de onda de 350 nm. Finalmente, la carga superficial de los PC fue caracterizada por la prueba potencial zeta, obteniendo un valor de -34.6 ± 4.38 mV, atribuido a la presencia de pares libres electrónicos de las especies a base de nitrógeno. Para determinar los niveles de L-Lactato se hará uso de la acción enzimática de la lactato oxidasa que convierte este analito en piruvato y H_2O_2 . Los cambios en las propiedades de fluorescencia de los PC serán proporcionales a la cantidad de especies de generadas y por tanto a la concentración de L-Lactato. La presente investigación ha arrojado resultados preliminares, y actualmente se están construyendo las curvas de calibración en presencia de H_2O_2 , lactato oxidasa y L-Lactato y acorde al objetivo principal planteado se espera obtener una respuesta fluorescente de los PC para detectar la presencia y posible cuantificación de L-Lactato en solución acuosa. Esta primera fase de la investigación hace parte de una propuesta más amplia, donde se busca la generación de una plataforma sensorial de L-lactato que no requiera de personal especializado para su interpretación o manejo de muestras, que espera obtener resultados comparables con respecto a sistemas de medición presentes en el mercado.

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Uso de Nanopartículas de Quitosano para Potenciar los Actuales Tratamientos de Leishmaniasis Visceral

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Tratamientos actuales para leishmaniasis visceral (LV) como el antimonio de meglumina, miltefosina y anfotericina, presentan limitaciones como la toxicidad en altas dosis por tiempo prolongado, resistencia del parásito al medicamento, y poca accesibilidad. La nanotecnología aborda estas problemáticas proponiendo sistemas de nanoencapsulamiento de medicamentos a base de polímeros y biopolímeros. El objetivo de esta revisión bibliográfica de artículos indexados desde el año 1989 hasta la fecha, fue entender si un sistema de nanopartículas de quitosano como alternativa de transporte para el tratamiento de la LV puede ser efectiva para el tratamiento de la enfermedad, brindando una alternativa con menos complicaciones. Teniendo en cuenta que el quitosano es un biopolímero no tóxico, mucoadhesivo, biocompatible, reticulante iónico, biodegradable y tiene propiedades analgésicas, antitumorales, hemostáticas, antimicrobianas, antioxidantes, antibacteriano, y antifúngico, se plantea como una excelente alternativa para el tratamiento de la LV a través de una liberación controlada de medicamentos que complementen la acción del quitosano reduciendo además los niveles de toxicidad de los medicamentos [1]. La fabricación de nanopartículas de quitosano para el tratamiento de la LV puede hacerse bajo los métodos de gelificación iónica, nanoemulsión, complejación ionotrópica, reticulación iónica, osmosis, liofilización y nanoprecipitación, reduciendo considerablemente la toxicidad del tratamiento con los medicamentos directos. Al realizar variaciones en las formulaciones de quitosano con diferentes rangos en su peso molecular (10kDa a 120kDa) se obtiene un diferente grado de desacetilación (70% a 85%). El medicamento utilizado (antimonio de meglumina, anfotericina, paramomicina, miltefosina), la dosis del medicamento (5ng a

20mg), y la adhesión de polímeros con carga superficial (positiva/negativa), el tamaño de la nanopartícula (102nm a 448nm), el perfil de liberación del medicamento (24h a 15 días), así como las relaciones molares de los mismos, hacen que se presenten variaciones en los resultados en la eficiencia de la encapsulación (48.4% a 97.8%). Esta revisión ha mostrado una importante actividad contra la LV y la reducción de la carga parasitaria en cualquiera de sus especies *Leishmania donovani*, *Leishmania infantum* o *Leishmania chagasi*, evidenciando que la mejor combinación de factores para el desarrollo de nanopartículas de quitosano, es con quitosano de bajo peso molecular para el diseño de portadores lipídicos nanoestructurados con Miltefosina y anfotericina, realizados mediante el método de emulsión, con un tamaño de partícula inferior a los 200nm, obteniendo así una inhibición de la LV del 88,14%. Una vez encapsulado el medicamento, éste no interactúa directamente con la membrana de la célula epitelial en comparación con el medicamento en estado libre, presentando una mayor hematocompatibilidad, mayor localización y distribución del fármaco a nivel de hígado, bazo y médula ósea [2],[3], y una menor concentración en el plasma siendo así más seguras vía intravenosa, disminuyendo además el riesgo de hemólisis, necrosis en hígado o riñón, y una mejor biodisponibilidad oral a través de una mayor permeabilidad intestinal [4]-[7].

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Mutagenicity and Cytotoxicity of Magnetite-BU-FII-Cas9 Nanobioconjugates as Non-Viral Vehicles for Gene Editing: preliminary evaluation in HFF and Ha-Cat Cell Lines

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Gene editing by CRISPR-Cas9 is an emerging approach that relies on Cas9/sgRNA ribonucleoprotein complexes to target and edit DNA. Currently for this technology, there is a lack of safe and effective delivery vehicles for the gene cargoes to the target cells [1][2]. Despite the popularity of viral vehicles, they exhibit safety issues as they can induce undesirable immune responses. Alternatively, nanomaterials have become an appealing replacement of viral vehicles due to their high surface to volume ratio, amenability for surface engineering to target specific tissues, and relatively low cost and ease of synthesis [3]. In this regard, a large arsenal of nanomaterials from different families are now available for the preparation of nanovehicles including metallic oxides, carbon-based materials and polymeric. Over the past few years, we have developed very potent cell penetrating nanovehicles obtained by interfacing magnetite nanoparticles (MNP) with cell translocating agents such as the peptide Buforin II (BUF-II) and the Outer Membrane Protein A (OmpA) [4][5]. Besides their abilities to internalize various cell lines and escape endosomes, they exhibit high stability and biocompatibility in vitro. Therefore, here we aimed at synthesizing magnetite-BUFII based nanobioconjugates as alternative delivery vehicles of recombinant Cas9. This was accomplished by functionalizing PEGylated MNP with co-immobilized BUFII and recombinant Cas9. Importantly, the Cas9 was immobilized after conjugation of the reducible linker 3-[(2-aminoethyl)dithio]propionic acid (AEDP) to allow easy delivery after reaching the intracellular space. We corroborated the correct synthesis through a physicochemical characterization by Fourier transform spectroscopy

(FTIR), dynamic light scattering (DLS) and thermogravimetric analysis (TGA). The FTIR demonstrated the presence of PEG vibrations, the DLS showed a hydrodynamic diameter of about 290 nm and the TGA a conjugation efficiency of about 5%. Additionally, we carried out cytotoxicity testing of the nanobioconjugates in HFF and HaCat cell lines, via a lactate dehydrogenase (LDH) assay. Additionally, we conducted platelet aggregation and hemolysis assays. These assays revealed high biocompatibility according to the 10993-1:2018 ISO standard [6]. Finally, we evaluated genotoxicity by the Ames test aided by the Salmonella typhimurium TA98 and TA100 strains to explore possible frameshifts and base-pair substitutions, respectively. Our results demonstrated that the nanobioconjugates induced negligible mutagenic effects. Taken together, our results indicate that our nanobioconjugates are good candidates for the efficient delivery of CRISPR/Cas9 therapies. Further studies should be dedicated to evaluating gene editing in vitro as well as intracellular trafficking details to assure nuclear localization and endosomal.

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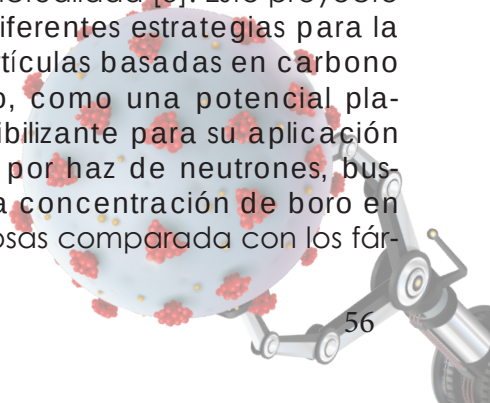
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Desarrollo de una nano-plataforma basada en puntos carbono dopados con boro para su potencial aplicación en la terapia contra el cáncer por captura neutrónica

Sergio Barragan, Diana Rodriguez Burbano and Alejandro Ondo

El cáncer es una de las enfermedades con mayor tasa de mortalidad a nivel global [1]. Dentro de los diferentes tipos de tratamientos que son utilizados para tratar esta enfermedad, la radioterapia es uno de los más frecuentes. El tumor se irradia con fotones (rayos X), induciendo daño al ADN y, por consiguiente, promoviendo la muerte celular. Sin embargo, gran cantidad de células sanas son afectadas al aplicar la radioterapia convencional por efecto de la radiación ionizante. Una alternativa a la radioterapia tradicional es la terapia por captura neutrónica de Boro (BNCT, por sus siglas en inglés), la cual utiliza neutrones que, al interactuar con el boro, generan un efecto radiactivo localizado en el tumor, reduciendo considerablemente el daño a células sanas. Esta técnica ha demostrado tener alto potencial para combatir tumores, principalmente los inoperables por accesibilidad. Sin embargo, sus costos son elevados y su efectividad puede mejorar si se logra obtener una mayor concentración de boro al interior de las células cancerosas [2]. Recientes estudios han demostrado que diferentes tipos de nanopartículas como los puntos de carbono, son candidatos prometedores en aplicaciones para combatir el cáncer debido a sus propiedades fisicoquímicas. A su vez, los puntos de carbono tienen alta capacidad de carga comparados con diferentes fármacos que se usan en la actualidad [3]. Este proyecto propone evaluar diferentes estrategias para la síntesis de nanopartículas basadas en carbono dopadas con boro, como una potencial plataforma radio-sensibilizante para su aplicación en la radioterapia por haz de neutrones, buscando aumentar la concentración de boro en las células cancerosas comparada con los fár-



macos que se usan en la actualidad. Los puntos de carbono fueron sintetizados por método microondas, optimizando parámetros como precursores orgánicos, fuentes de boro, y la temperatura de reacción. Debido a sus propiedades ópticas de absorción y emisión, los precursores seleccionados fueron L-histidina y ácido cítrico en proporción 1:1, dispersos en agua destilada a una temperatura de 200°C por 10 minutos. Los puntos de carbono sin dopar dispersados en solución acuosa presentan bandas de absorción en el rango de 200 nm a 500 nm asociadas a las transiciones $\pi \rightarrow \pi^*$ y $n \rightarrow \pi^*$ que indican la presencia de enlaces C-OH, C-O-C, C=O y C=N; adicionalmente, los puntos de carbono exhiben bandas de emisión en el rango de 490 nm a 700 nm al ser irradiados con luz de 440 nm. La carga superficial se caracterizó por potencial ζ obteniéndose un valor de -7.3 mV, lo que sugiere presencia de grupos funcionales hidroxilo, carboxilo y carbonilo en la superficie de la nanoplateforma. Se realizó una evaluación preliminar de toxicidad mediante la prueba de MTT, en cultivos de células tumorales (HT29) y sanas (3T3-L1). La prueba se realizó a una concentración de la nanopartícula sin dopar de 500 $\mu\text{g/ml}$ durante un lapso de 24 horas. Se observó una viabilidad celular de $97\% \pm 4.83\%$ en la línea celular HT29 y $89.3\% \pm 15.11\%$ en la línea celular 3T3-L1. Este estudio se encuentra en curso y actualmente se está llevando a cabo proceso de caracterización de los puntos de carbono dopados usando ácido bórico como fuente de boro al 1%, 2%, 5%, 10% y 20%, y se espera iniciar experimentos de radiación con neutrones in vitro en células con la nanoplateforma. Este estudio es de gran importancia ya que es el punto de partida para continuar con la investigación en nanoplateformas radio-sensibilizantes que permitan aumentar la eficacia de técnicas como BNCT.

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Funcionalización de puntos de carbono dopados con gadolinio para su uso en radioterapia

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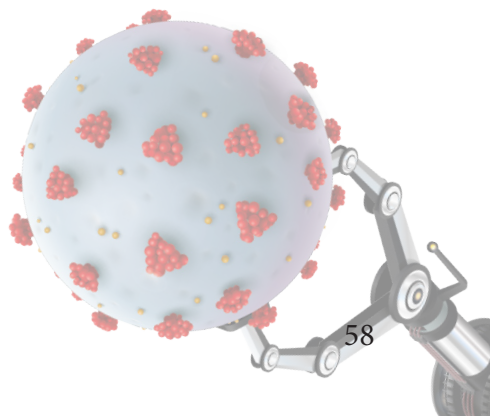
Cerca de 19 millones de personas fueron diagnosticadas con cáncer en el año 2020, según el estudio de globocan [1]. La mayor parte de estos pacientes son sometidos a tratamientos quirúrgicos y expuestos a radioterapia. La radioterapia es un tratamiento no invasivo que hace uso de energías ionizantes, que generan daño en el ADN de las células cancerosas [2]. Sin embargo, la radioterapia se enfrenta a un problema, la alta radioresistencia presentada por algunos tumores [3]. Debido a esto, se han investigado alternativas para el tratamiento que potencien la energía depositada en las zonas afectadas, entre estas el uso de puntos de carbono y estructuras de metal orgánico (por sus siglas en inglés MOFs). Estas nanoestructuras permiten el desarrollo de nanoplateformas que aumentan la concentración de agentes radiosensibilizantes en zonas localizadas o la optimización del efecto producido por la radiación, incrementando el número de especies reactivas de oxígeno (ROS) y radicales libres generados. Los MOFs son nanopartículas híbridas, compuestas por ligandos orgánicos unidos a átomos o clúster metálicos. Se caracterizan por su estructura ordenada, con una gran área superficial y alta porosidad, útil en el almacenamiento y transporte de medicamentos; así mismo, debido a su composición presentan una baja citotoxicidad y permite modificar y ajustar sus propiedades variando sus componentes orgánicos y metálicos [2]. Los MOFs han sido usados en radioterapia como almacenadores de medicamentos radiosensibilizantes y como agentes antioxidantes. De igual forma, los puntos de carbono han sido usados como agentes radiosensibilizantes al ser dopados con elementos de alto número atómico como el GD^{3+} , que al ser incorporado en la nanoplateforma evita su desprendimiento y acumulación en te-

jidos. El objetivo de este proyecto es el desarrollo de un agente radiosensibilizante, basado en una nanoplateforma de MOFs funcionalizadas con puntos de carbono dopados con Gd^{3+} , con el fin de analizar si la unión de dichos materiales representa una mejora de sus desempeños individuales. De igual forma, caracterizar la generación de ROS post-irradiación. Como primera etapa del proyecto, se sintetizaron puntos de carbono por medio del método de microondas. La temperatura óptima de la reacción se determinó a $200^{\circ}C$ a la cual se obtuvieron puntos de carbono de tamaño de 110 nm y una carga superficial de -26.5 mV, propiedades determinadas por DLS y potencial zeta respectivamente. Los puntos de carbono muestran bandas de absorción a 335, 365 y 410 nm correspondientes a las transiciones $\pi \rightarrow \pi^*$ y $n \rightarrow \pi^*$ y bandas de emisión que abarcan el rango de 440 a 560 nm bajo irradiación a 335, 365 y 410 nm. Se realizaron pruebas de viabilidad celular por el ensayo de MTT en la línea celular HT29, a concentraciones de 50, 125, 250 y 500 $\mu g/ml$ de puntos de carbono sin dopar y puntos dopados con Gd3 con un porcentaje de dopaje de 6.66% p/p. Las células con puntos sin dopar a una concentración de 500 $\mu g/ml$ mostraron una viabilidad del $95 \pm 15\%$. Así mismo, para las células con puntos dopados a la misma concentración se obtuvo una viabilidad del $77 \pm 0.77\%$, al disminuir la concentración de los puntos a 125 $\mu g/ml$ se genera un aumento en la viabilidad celular al $86.2 \pm 0.59\%$ por lo cual se considera el uso a concentraciones iguales o inferiores. los puntos de carbono sintetizados muestran una baja citotoxicidad y propiedades óptimas. Por otro lado, los puntos dopados con Gd^{3+} a una alta concentración presentan una disminución de biocompatibilidad. Hasta el momento, se incluyen resultados parciales del proyecto, se espera continuar con el proceso de síntesis de los Mofs basados en la arquitectura UIO-66, usando ácido tereftálico como ligando orgánico y cloruro de hafnio como el componente metálico debido a su alto número atómico, completar el proceso de funcionalización de los Mofs con los puntos de carbono, así como, el proceso de caracterización y concluir las pruebas de generación de ROS.

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Desarrollo de una nano-plataforma basada en puntos de carbono co-dopados con N y Gd³⁺ como potencial agente radio-sensibilizante

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El cáncer es una de las principales causas de muerte en el mundo. Puede tratarse desde diferentes aproximaciones, buscando la eliminación o la disminución del tamaño del tumor. La radioterapia es uno de los tratamientos más usados, y tiene como objetivo inducir la muerte celular como consecuencia de las rupturas de la cadena de ADN producidas por la radiación [1]; no obstante, afecta a células tumorales y a células sanas en la misma proporción, generando efectos secundarios nocivos para el paciente. A pesar de los grandes avances en la generación de tecnologías para la radioterapia, es necesario el desarrollo de nuevas estrategias que permitan concentrar la radiación en los tejidos tumorales y mitigar la interacción con los tejidos sanos a través de tecnologías radiosensibilizantes o radioprotectoras respectivamente. Los puntos de carbono (PC) son una opción al desarrollo de nuevas estrategias. Los PC son nanopartículas basadas en su mayoría por carbonos sp² /sp³ biocompatibles que presentan estabilidad acuosa coloidal, que exhiben fluorescencia, y pueden ser usadas como base para el diseño de agentes radiosensibilizantes [2]. Con el fin de incrementar los efectos indirectos que liberan los radicales libres que rompen el ADN, en este trabajo se propone la incorporación de iones Gd³⁺, el cual permitirá aumentar la densidad electrónica debido al alto número atómico que posee y en consecuencia la probabilidad de interacción con los fotones de la radioterapia. Adicionalmente, la mayoría de los PC exhiben una fluorescencia intrínseca en el rango azul del espectro electromagnético, región donde varios fluoróforos endógenos de los tejidos humanos presentan altos coeficientes de absorción [5]. Por tal razón se propone incluir especies nitrogenadas en el proceso de síntesis, favoreciendo la gene-

ración de PC capaces de emitir fluorescencia a mayores longitudes de onda que disminuirá la energía absorbida por los tejidos. La síntesis se realizó por medio del método solvotermal, a una temperatura de 160°C por un tiempo de 12h, usando como precursores Urea y Ácido cítrico como fuentes de nitrógeno y como solvente Formamida. Este trabajo se encuentra en proceso de desarrollo, los resultados de espectrofotometría UV-Vis muestran bandas de absorción en 230nm y 347nm que indican presencia de enlaces C=C y C=N, respectivamente. Se observa una carga superficial de -34,6 ±4,8mV por medio de la medición de potencial Zeta, y la viabilidad celular evaluada de manera preliminar a una concentración de 500µg/mL de PC en las líneas celulares HT29 Y 3T3 del 99,57% con desviación estándar de 0,729 y 92,23% con desviación estándar de 6,896, respectivamente. Hasta el momento se presentan resultados preliminares sobre la síntesis, caracterización y viabilidad celular de las nanopartículas, además se encuentra en proceso de desarrollo las pruebas de incorporación de Gd³⁺ al 20% del peso del ácido cítrico, las pruebas de citotoxicidad y evaluación de las propiedades ópticas para dar continuidad a la segunda fase del proyecto.

ID: 107

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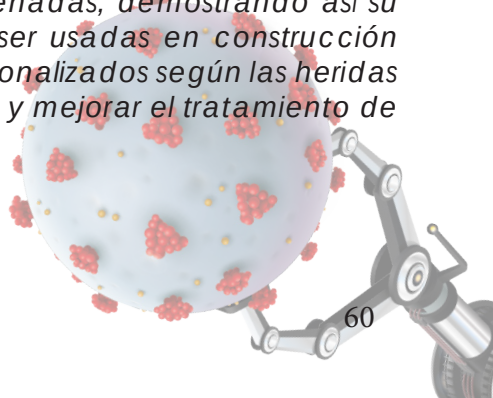
Diseño de una Tinta de Biomaterial a Base de PEGDA y Gelatina para Potenciales Aplicaciones en el Desarrollo de Apósitos Personalizados para Úlceras Crónicas de Pie Diabético

Sofia V Mateus-Suarez, Michelle M Torres-Pinzon, Victor A Solarte-David and Silvia M Becerra-Bayona

La diabetes es una enfermedad crónica que afecta mundialmente al 9.3% de adultos con edades entre los 20 a 79 años [1]. Entre las complicaciones más severas se encuentran las úlceras crónicas de pie diabético (UCPD) [2], las cuales se derivan de compresiones altas en áreas específicas y afectan la integridad de la piel [3]. Dentro de las terapias comunes, se implementan apósitos que proporcionen un ambiente óptimo para una cicatrización adecuada, dado que imitan una matriz extracelular (andamio) [4], sin embargo, estos no consideran dimensiones y morfología de la úlcera [5]. Estos andamios pueden fabricarse a base de hidrogeles, con polímeros como el polietilenglicol diacrilato (PEGDA) que posee propiedades de preservación de integridad de las estructuras construidas [6], y ha sido empleado en aplicaciones de suministro de fármacos [7]. No obstante, su baja viscosidad a temperatura ambiente impide que sea utilizado para la impresión 3D [8], por lo que es necesario adicionar un agente para aumentar la imprimibilidad durante la extrusión, de modo que se propuso el diseño de una tinta de biomaterial de PEGDA y gelatina para impresión 3D con potencial aplicación en el desarrollo de apósitos personalizados para úlceras crónicas de pie diabético. Por lo tanto, se evaluó la capacidad de formación de filamentos para soluciones con diferentes concentraciones de gelatina, luego se seleccionó la concentración que presentara una extrusión de filamento más prolongada y uniforme para un estudio preliminar de las condiciones de imprimibilidad a través de la impresión de rejillas cuadradas a parámetros de flujo

150, 250 y 350% y velocidad de 2 y 5 mm/s, donde se evaluaron el coeficiente de imprimibilidad para la formación de cuadrados y el error del área interna de las cuadrículas. La solución de gelatina se utilizó como agente para aumentar la viscosidad de las soluciones de PEGDA al 10, 20 y 30%p/v, y así fabricar una tinta de biomaterial imprimible por extrusión, y luego liberar térmicamente la gelatina de la estructura fotopolimerizada. Por esto se realizaron estudios de cuantificación de proteínas con hidrogeles fabricados con las tintas y estructuras impresas donde se evaluó, después de hinchamiento con PBS por 48 horas, la concentración de gelatina en el medio. Además, se realizó una caracterización mecánica de los hidrogeles fabricados con las tintas, mediante ensayos de tracción y compresión para analizar el efecto de la gelatina en estas a comparación de los controles de PEGDA. Finalmente se evaluó la imprimibilidad de la tinta de PEGDA y gelatina, utilizando los mismos parámetros que en los anteriores experimentos. La solución de gelatina al 6%p/v presentó una formación de filamento idónea y fue seleccionada para añadirla en la tinta de biomaterial con PEGDA. Se evidenció la liberación de gelatina tanto en los hidrogeles como en las impresiones, por lo tanto, se comprobó su capacidad para actuar como matriz de sacrificio al permitir la impresión por extrusión, y luego separarla parcialmente de la estructura fotopolimerizada. Esto también se comprueba con la comparación de los módulos de elasticidad y compresión, ya que no se evidencian diferencias significativas donde la inclusión de la gelatina afecte a las estructuras después de hinchamiento. En la evaluación de imprimibilidad se obtuvo el mejor resultado con la combinación de parámetros de flujo a 350% y velocidad a 2mm/s. Finalmente, se obtuvieron tintas de biomaterial con una óptima imprimibilidad según la fidelidad en la morfología y dimensiones diseñadas, demostrando así su potencial para ser usadas en construcción de apósitos personalizados según las heridas de los pacientes y mejorar el tratamiento de las UCPD.

ID: 34



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2^{do} CONGRESO INTERNACIONAL
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Biomecánica

Dynamic model of flexion/extension and abduction/adduction of the shoulder joint complex

Jose Luis Sarmiento, Annette Paola Rojas and Yendy Zaurith Rueda

This work presents the modeling, control, and simulation of flexion/extension and abduction/adduction of the shoulder joint complex. The dynamic models of the shoulder movements are obtained using Euler-Lagrange formulation, and are built in Simulink (MATLAB) using the nonlinear secondorder differential equations derived from the dynamic analysis. An angular displacement feedback PID control, representing the human natural neuromusculoskeletal control, is implemented in the model for trajectory tracking of the shoulder movements. Simulations are carried out for the average Colombian adult and using sinusoidal waves as reference trajectories, and the angular displacement tracking is evaluated in terms of the maximum relative error (RME) and root mean square error (RMSE). Simulations results showed superior angular displacement tracking with errors below $0.82[^\circ]$ in magnitude and 1.23%.

ID: 8

Community-based Collaborative Design in Rehabilitation Engineering: A case study at a Penitentiary Institution

Karol Daraviña Ruiz, Andres Mauricio Gonzalez-Vargas, Oscar Campo and Paola Andrea Luján

Social responsibility and biomedical engineering come together in the area of rehabilitation engineering, making it an important component for social construction and generation of positive impact in the community. This paper presents the community work carried out with between the Universidad Autónoma de Occidente and the Rehabilitation Area of the Medium Security Prison of Cali (EPMSC), where the design and manufacture of a low-cost mechanotherapy device for patients with disabilities were carried out. A new methodology was used, which combines components of social intervention and engineering. Here, we assess the importance of social responsibility in community projects, the link between engineering and the community, and highlight communitybased collaborative design as an experience that contributes to a sustainable environment and an accessible world

ID: 9



Design of a Prototype Limb Orthosis of the Canis Lupus Familiaris for Hip Support in Dysplasia and Surgical Recovery Processes

*Karen Tatiana Valencia Rivero and
Adriana Valentina Rodríguez*

This study aimed to design a prototype orthosis to improve stability on hind limbs of the German Shepherd dog (*Canis Lupus Familiaris*) for the treatment of hip dysplasia and support in the hip surgical recovery process. A bibliographic review of the parameters of the flexo-extension segments and angles for each articulation of the hindlimbs in the *Canis Lupus Familiaris* (CLF) was performed to calculate the stress exerted on the coxofemoral joint involved in hip dysplasia while the dog is in motion or in a static position. A static and dynamic study of forces was carried out as part of this biomechanical study to propose a prototype design. Prototype was designed with CAD Inventor and Solidworks Software version 2019 under design criteria that included: to be a comfortable prototype, easy to handle, adjustable, easy to manufacture with a biocompatible material, affordable, and allowing the dog to walk and adopt any posture with ease supporting the weight of the animal. Hip orthoses design developed in this study, may support surgical recovery processes, decrease the degree of dysplasia, and even decrease the effects of osteoarthritis, thus improving the quality of life of the dog and providing a starting point for the development of this type of orthosis in dogs of other breeds.

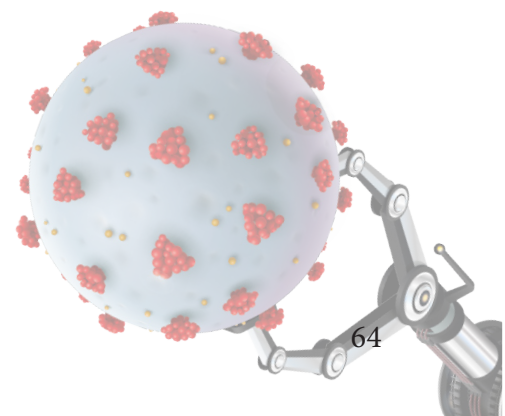
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Biomechanical modeling of a taekwondo kick (Dollyo Chagui)

Sofía Valentina Mateus Suárez; Daniel Felipe Rincón; Freddy Alexis Sierra Sánchez; Michelle María Torres Pinzón; Lusvin Amado

This article supports the biomechanical analysis of the taekwondo kick, Dollyo Chagui. It was recorded by means of electromyography equipment, optoelectronic cameras, inertial sensor, and force platform, for data processing in BTS Bioengineering, Matlab and G-STUDIO software, in which the respective analysis of each shot is made. The characterization of the movements of 3 subjects with different experience in sport is presented, in order to show the differences in the movement technique. Subject 3 is a woman who is at a beginner level, her taekwondo practice began at the time of this research, subject 2 has an advanced level and has practiced taekwondo for the last 6 years, finally, subject 1 has a higher level with 9 years of experience in taekwondo and is dedicated to the modality of poomsae. Based on the records, the correct angles, muscle activation and positions that should be taken in each phase of the kick can be obtained, in order for the taekwondo athlete to improve in his execution and teaching. From the results obtained, the importance of a good technique to have a more efficient kick can be evidenced, as well as the importance of each of the 5 phases proposed.

ID: 11



Biomechanical analysis protocol of the arabesque position in the ballet

Lusvin Amado, Isabela Arévalo Gutiérrez de Piñeres, David Josue Gómez López, Alba Sofía Higuera Delgado and Mariana Silva Garcia

This paper will present the biomechanical analysis for the good positioning of the arabesque in ballet. The arabesque or arabesque is one of the main positions in classical ballet. The dancer is in profile, holding on one leg and keeping the other leg extended backwards, the hands are in various harmonic positions. This procedure is a comparison of the positioning between a professional ballet dancer and a beginner. It is known that this position in ballet is one of the major causes of injuries, mainly in the hip and ligaments, in dancers. For this reason, a static analysis of the position is made, determining as many variables as possible to help dancers to improve their position and avoid this type of injuries.

ID: 46

Biomechanical analysis of delivery cyclist posture's

Nicolas Yanguma Muñoz, Kevin Alejandro Giraldo, Brayan David Solorzano and Christian Cifuentes De La Portilla

Due to the COVID-19 pandemic, food e-commerce and delivery demand increase radically in 2020. Indeed, the Colombian delivery cyclist population growth from twenty thousand in 2019 to approximately fifty thousand in 2020. Some unconsidered factors might have affected the delivery cyclist biomechanical behavior and their health. Also, the growth in this population implies more people are affected if they do not consider biomechanical factors in the sporting gesture. Thus, this work aimed to analyze the loading effect on the delivery cyclist posture and related health issues. Kinetic and kinematic analysis of delivery cyclist posture under several conditions has been performed using computational models and motion capture analysis. The results presented in this work suggest that the cranioventral and shoulder sagittal angular variations are affected by the loading increase. Furthermore, the computational model indicates an accumulation of compressive and tensile stress focused on the lumbar area, indicating the need for a new backpack design. In conclusion, this work presented the dangerous effects of load-carrying in the delivery cyclist posture and proposed new backpack design alternatives to solve this problem

ID: 49



3D model of the knee joint as a tool for the study of surgeries and injuries such as ACL reconstruction

Mónica Rocio Gantiva Díaz, Laura Maria Dussan Delvasto and Christian Javier Cifuentes de la Portilla

Anterior cruciate ligament (ACL) injury is one of the most common injuries in athletes, accounting for 50% of all knee ligament injuries. It is caused by impacts to the knee joint, abrupt and sudden changes of direction, among others. A common treatment is ACL reconstruction surgery, for which there are different variations to be performed. One of them is the replacement of the ACL with a section of the patellar tendon taken from the same affected knee of the patient. This results in a change in the mechanical properties of the reconstructed ACL where it is not possible to quantitatively measure changes in intra-articular stresses. For this reason, in this project a 3D model of the knee joint has been made by means of diagnostic image segmentation in order to allow prediction of possible changes in the stability of the knee. The model presents the main bone components and stabilising soft tissues such as ligaments and menisci. To obtain a model of the surgery, the width of the quadriceps tendon is reduced and the mechanical properties of the ACL are changed to those of the tendon used. Simulations of body weight application in standing, in a flexion movement of the joint and in reaction to heel strike during human gait are performed. The results obtained are validated and compared with results reported in the literature. The results obtained show that in most cases this surgery causes an increase in the stresses exerted on the ACL. Thus, this model is an alternative as a decision tool to evaluate the possible biomechanical changes of the knee before performing this ACL reconstruction surgery.

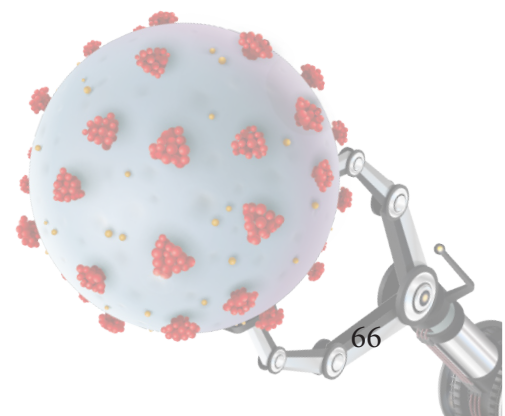
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Design of a Prosthetic Foot with Passive Actuator

Giovanny Romero, Edilberto Mejia Ruda and Ruben Dario Hernandez Beleño

In daily life, walking represents one of the most important biological processes, as well as the most used. When taking into account this, a person who loses a section of some lower limb presents problems or difficulties to carry out a certain process, it is for that reason, that the design of a prosthetic foot with mechanical actuator is carried out; which, taking as a starting point an analysis in a walking laboratory, in which the reaction forces of the foot with the ground, which were processed by MATLAB®, will be obtained as a starting point; likewise, through an analysis in the literature, the ideal material and actuator for the objective that is needed is sought. The implementation of the design is carried out through SolidWorks®, where through the combination of a carbon fiber structure, and the implementation of a passive actuator, such as the spring, it is possible to emulate the forces that would normally perform the muscles that were lost.

ID: 110



Design of transtibial mechanical prosthesis with feedback to ground irregularities

Juan Contreras Marquez and Christian Cifuentes-De la Portilla

Many of the mechanical prostheses available do not have many of the important characteristics of the foot, such as flexibility, mobility and the ability to adapt to any type of terrain. Furthermore, as it is an artificial extension, people do not have sensory control over it and terrain adaptation depends entirely on the design of the prosthesis. This document proposes the design of a transtibial mechanical prosthesis capable of adapting to uneven terrain that will provide the user with feedback when a slope is detected. The proposed design is based on state-of-the-art functional models that are based on the shape and mobility of the human foot. The adaptability to uneven ground depending on the plantar mobility of the foot given by an ankle joint placed in the prosthesis. This plantar mobility allows to feedback about the level of inclination of the terrain through the use of sensors and actuators that transmit stimuli to the person's stump with information about different inclination conditions. The prosthesis also has two shock absorbers that help distribute the load when the heel strike occurs, these are made of fiberglass that has properties close to carbon fiber. The sole of the foot is flexible enough to adapt to small irregularities in the terrain. Additionally, this design features an ankle joint in order to emulate the kinematics of heel strike and toe-off that occurs during gait. The entire prosthesis, except for the shock absorbers, was created in 3D printing using PLA as a material, which facilitated and economized its manufacture. During the experimental tests this design proved to be functional subject to future improvements.

ID: 82

Validation of a rotator cuff finite element model to study shoulder injuries

Luis Eduardo Ortega Ortiz, Juan Sebastian Salgado Manrique, Gustavo Gil, Jairo Villa and Chrstian Javier Cifuentes de la Portilla

Glenohumeral joint arthrosis development is yet to be fully understood, mainly due to arthrosis origin not being fully understood. Only some factors such as age, gender or past joint fractures have been associated with its development. Although joint complexity and the challenges of an in-vivo study, computer-based analysis has proven to be useful and a viable tool to understand joint failure and fatigue. Taking this into account, a finite element model of the glenohumeral joint could allow professionals to understand how rotator cuff injury induces glenohumeral arthrosis development. Furthermore, if the finite element model is fine-tuned based on in-situ measurements, such as Glenohumeral muscles forces and force changes due to injury. The finite element model would be more robust, reliable and credible Firstly, based on a CT scan a 3D segmentation of the glenohumeral joint was created (including humerus, clavicle and scapula). Afterwards, rotator cuff muscles (Supraspinatus, Infraspinatus, teres minor and subscapularis) were segmented with the coracohumeral and glenohumeral ligaments. This final model could then be fine-tuned based on the inter-articular forces measured by a new novel in-situ FSR based circuit in cadaveric pieces. Doing so, this validated model could help identify what muscle or group of muscles contributes more to the development of glenohumeral joint arthrosis.

ID: 87

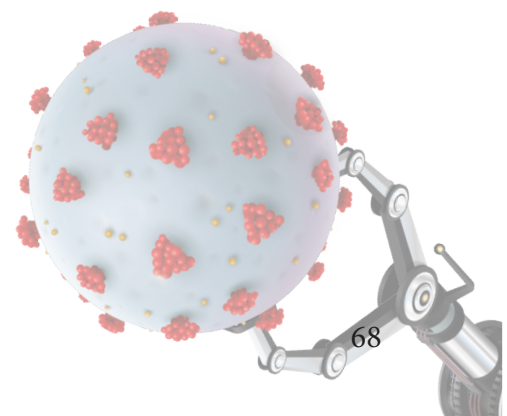


3D Design of a Prosthetic Hand Prototype

*Michael Alexander Guerra Jaramillo and
Ricardo Alonso Espinosa Medina*

Access to functional prosthetic hands in developing countries such as Colombia is limited by economic, geographical, and technological factors. For this reason, a large number of patients with an absence of an upper limb do not have the possibility of acquiring prostheses and regain autonomy in activities of daily living. Commercial prostheses are expensive, require several annual maintenance assignments and complex training leading to premature abandonment of the prosthetic device. This paper presents the design of a myoelectric prosthetic hand prototype, which seeks to meet the most important needs of the upper limb amputee individual, starting from a low-cost approach, an intuitive control interface and the use of the most important degrees of freedom to achieve daily live activities. The mobility of the phalanges and joints was simulated in a computer system that allows the design in 3D, from the data processed by goniometry of the human hand. An actuation and control system were designed using a bioinstrumentation system, servo motors and a microcontroller. This proposal is a design phase, and it is expected in the next phase to be able to do the physical assembly and validation in the patient.

ID: 117



Evaluation of tension forces in thoracic box of an amateur rugby player caused by a tackle

Nicolas Yanguma Muñoz and Christian Cifuentes De La Portilla

Tackles are frequent in rugby and can be received in different parts of the body, such as the thoracic box, abdomen, or head [1] [2]. Evidence reported suggests that this kind of impact on the thoracic box can produce injuries like muscle damage, rib fractures, and in extreme cases, death [2] [3]. However, details of the biomechanics effects on the ribs are unknown, mainly because these cannot be measured by traditional methods. This study aimed to analyze the risk of injuries in ribs and cartilage during this hit, considering both lateral and frontal impacts. A finite element model of the thoracic box was reconstructed from CT images of a 28-year-old male healthy patient. Two models were performed: a basic model (BM), which only considered cortical bone of the ribs and the cartilage, and a complete model (CM), which differentiate cortical and trabecular bones. Tissues were modeled as elastic-linear materials. The biomechanical properties were taken from the literature: (BM) $E = 6820$ MPa and $\nu = 0.375$ for cortical bone (CM), $E = 11500$ MPa and $\nu = 0.3$ for cortical, $E = 40$ MPa and $\nu = 0.45$ for trabecular bone and in both cartilage models $E = 1200$ MPa and $\nu = 0.2$ [5]. Meshing was performed in Ansys-ICEM CFD V. 19.2. Simulations were performed constraining the model by fixing some nodes in the spine (T1 and T12) and applying forces in the evaluated hit direction. A trial-error approach was employed to optimize the mesh size of each segment [4]. Static simulations and post-processing analysis were performed in ABAQUS / CAE. Evaluations were based on principal minimum stress ($S_{\min}$) values because these eigenvalues are related to compression stress, and results were normalized from 0 to -110 KPa. Results suggest that the risk

of suffering injuries increases when a lateral tackle is received. Principal minimum stress is higher in the rib's region (-45 KPa (frontal) to -63 KPa (lateral)), and the force magnitude along with the affected area increases when the hit occurs underside of the thoracic box, specifically between ribs 4 to 6 (fig 1E-F). Finally, there are significant differences between the models due to a considerably lower force magnitude in the BM (fig 1A-C). These results suggest that considering only cortical properties is not adequate for these kinds of computational studies.

ID: 39

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Biomechanical stress changes in Peroneus Longus tendon caused by midfoot joint arthrodesis.

Brayan David Solórzano Quevedo, Christian Javier Cifuentes De la Portilla, Chandra Pasapula and Javier Bayod

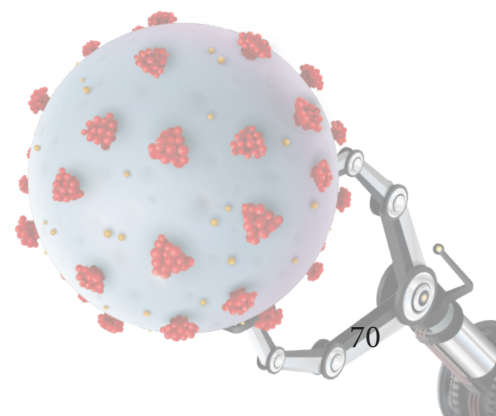
The adult acquired flatfoot development is mainly caused by weakness of the Plantar Fascia [1], alterations in the Spring ligament [2], or dysfunction of the Posterior Tibialis [3]. Current research has shown that these alterations of the passive stabilizers of the arch foot cause a notable increase in the stress on Peroneus Longus tendon. The plantar section of this tendon tends to become overloaded especially with plantar fascia weakness [4]. One of the methods used to correct the deformity caused by flatfoot is midfoot joint arthrodesis [5]. Some studies have shown that these joint fusions generate some side effects on other tissues and joints of the foot. However, there are few reports of the alterations caused on the Peroneus Longus, mainly because it is difficult to measure any stress changes in tissues. Hence, this work aimed to determine the alterations that the Peroneus longus suffers when there is an arthrodesis in the midfoot joints, using the finite element modeling. This study is based on the model designed and validated by Cifuentes De la Portilla et al. (2019). This model reconstructs a healthy human unloaded foot, based on CT- images acquired from the right foot of a 49-year-old male - weight: 720 N and height: 1.70 m [6]. The model tissues were considered as an elastic-linear material. Cortical bone ($E = 17,000 \text{ MPa}$, $\nu = 0.3$), trabecular bone ($E = 700 \text{ MPa}$, $\nu = 0.3$), ligaments ($E = 250 \text{ MPa}$, $\nu = 0.28$) and Plantar fascia ($E = 240 \text{ MPa}$, $\nu = 0.28$). To model the cartilage tissue, a nonlinear and hyperelastic model was used.[6] The parameter analyzed to evaluate the peroneus longus stress was maximum principal stress, using the field output spectrum of Abaqus CAE v.6-14. To identify the contribution of arthrodesis by modifying Peroneus Longus tension, different combinations of Spring ligament, Plantar Fascia, Posterior Tibial tendon failures were per-

med (tissue were removed from the model), simulating each case with different arthrodesis of the midfoot. The implemented simulation results suggest that the weakness of the Plantar Fascia and the arthrodesis of the CalcaneoCuboid joint mainly affect the tension of the Peroneus Longus. Moreover, flatfoot caused by failure of the main stabilizers is the worst case, and none of the arthrodesis analyzed succeeded in reducing the stress values on the Peroneus Longus. On the other hand, arthrodesis of the Talonavicular and Naviculocuneiform joint helps to reduce foot deformity without affecting the stress on the Peroneus Longus tendon.

ID: 50

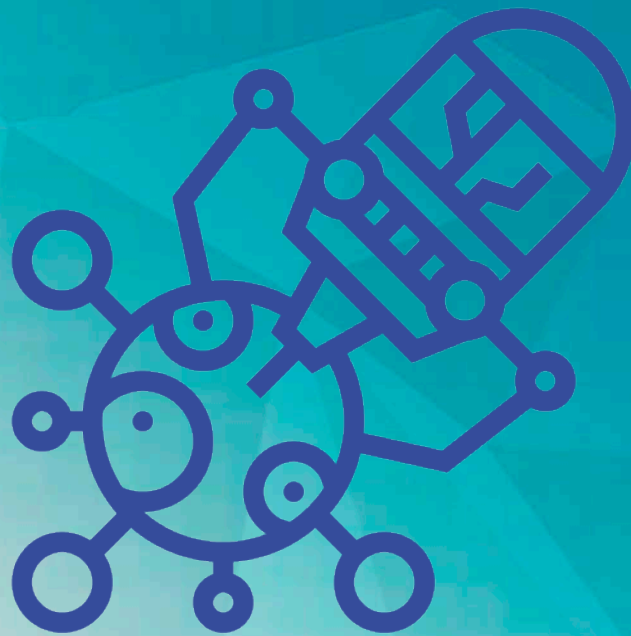
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Biotechnología

Novel anticancer agents based on co-immobilization of Temozolomide and Hydroxyurea on Magnetite-Buforin II nanobioconjugates: efficacy study in 3D Glioblastoma spheroids

Maria Ximena Forero Farias, Carlos David Suarez, Manu Forero-Shelton, Verónica Akle, Juan C. Cruz and Carolina Muñóz

Drug resistance in cancer patients is a currently growing worldwide problem that affects nearly 50% of glioblastoma multiforme patients who receive the chemotherapy drug Temozolomide (TMZ) as the main treatment. This critical issue needs to be addressed, considering that in this type of pathologies, time for intervention is limited by the short life expectancy (12-14 months). This has led to the need for more robust in vitro models to evaluate the performance of the treatments and possible resistance prior to clinical testing. Therefore, the present work seeks to propose and evaluate the performance of a 3D spheroid model for glioblastoma such that a greater similarity to native tumor tissue is intended in terms of structure and drug diffusion properties. This model was compared to traditional 2D cell cultures and demonstrated significant differences in cell viability after treatment with TMZ. This was attributed to the influence of cell packing density of the formed spheroids on the TMZ's penetration. The obtained results confirmed the low penetration of TMZ on spheroids, which largely explains the observed resistance clinically. An attractive alternative to improve penetration is the use of nanovehicles for delivery, as they have demonstrated superior cell penetration abilities when functionalized with biological and synthetic cellpenetrating agents. We have functionalized magnetite nanoparticles with the peptide Buforin-II to produce nanobioconjugates with remarkable membrane translocation potency. We propose to employ these nanobioconjugates to deliver Hydroxyurea, a compound with superior antitumor activity.

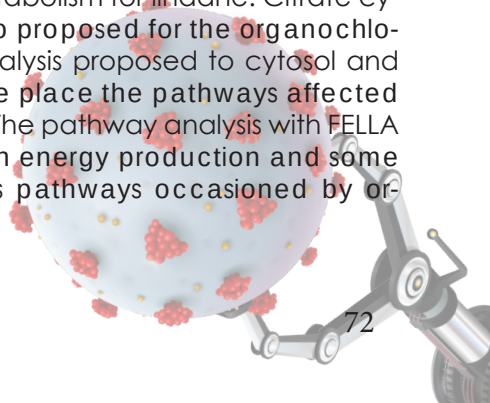
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Metabolic pathway analysis in HepG2 cells exposed to organochlorines using null diffusion-based enrichment

Jorge Alejandro Lopera-Rodríguez, Martha Zuluaga, Sergio Picart-Armada and Alexandre Perera Lluna

Organochlorines are a group of organic pesticides developed to control insect plagues, but with a relevant impact for human health. Intoxication caused by organochlorines can cause serious health compromises that can lead to death. However, the organochlorines molecular mechanism remains unclear. Therefore, researching about this topic is necessary to propose new therapeutic approaches. This study presents a bioinformatics approach to elucidate the metabolic pathways involved in organochlorines exposure using strategies based in recursive feature elimination with support vector machines (SVM—RFE) followed by an enrichment pathway analysis with null-diffusion. Five groups of HepG2 cells were exposed to aldrin, DDT, endosulfan, lindane, and a mixture of them. A control group with dimethyl sulfoxide was included. A metabolomic analysis was done using GC/MS-TOF, followed by SVM-RFE and a pathway analysis using FELLA and MetaboAnalyst. Genes reported by FELLA were introduced in GO gene ontology platform to estimate cellular components where reactions associated to organochlorines occur. Results: 153 metabolites were identified in metabolomic analysis. SVM-RFE was trained with datasets obtained and the linear kernel showed the best performance. A metabolites top ten for each organochlorine was obtained. FELLA identified to the pentose phosphate and the central carbon metabolism in cancer as common pathways for organochlorines. MetaboAnalyst pathway analysis proposed to the pentose phosphate and the lysine degradation as relevant pathways for aldrin, DDT, and the mixture. Alanine, aspartate and glutamate metabolism for endosulfan, and taurine and hypotaurine metabolism for lindane. Citrate cycle pathway was also proposed for the organochlorines mixture. GO analysis proposed to cytosol and exosomes where take place the pathways affected by organochlorines. The pathway analysis with FELLA suggests an impact in energy production and some amino acid synthesis pathways occasioned by organochlorines.

ID: 96



Evaluation and Characterization of Antioxidant and Immunomodulatory Activities of Colombian Sugar Cane-derived Extracts

Laura Rueda-Gensini, Julian A Serna, Natalia Bolaños, Jader Rodriguez, Juan C Cruz and Carolina Muñoz-Camargo

The increasing interest in polyphenolic compounds, due to their strong antioxidant activities, has gathered attention around natural extracts for the development of nutraceutical and therapeutic agents. Although sugar cane (SC) has long been known for its high polyphenol content, composition-wise variability in SC-derived products, as well as scattered research in different fields has limited the exploitation of their potential as nutraceuticals and therapeutics for numerous diseases. Here, we assess and characterize the antioxidant and immunomodulatory potential of SC-derived extracts, namely sugar cane juice (SCJ), syrup (SCS) and non-centrifugal sugar (NCS). The radical scavenging potential of all extracts was evaluated and compared with DPPH and ABTS assays, in which SCJ showed a reduced scavenging potential as a result of SC milling, but a prompt recovery was observed upon thermal processing. Moreover, the quantification of secreted cytokines by LPS- and *S. aureus* lysate-stimulated macrophages in the presence of SC-derived extracts demonstrated that SC derivatives exhibit strong anti-inflammatory activity. These results highlight the enormous therapeutic potential of SC derivatives, which could be exploited for alleviating the effects of diseases associated with chronic inflammation pathologies, such as cancer, diabetes, or neurodegeneration.

ID: 97



Extracto de Uva Isabella como Potencial Agente Quimiopreventivo sobre el Cáncer de Mama

M. Daniela Vélez and Gloria A Santa-González

El cáncer de mama surge de la proliferación descontrolada de las células mamarias tanto en hombres como mujeres, siendo mayor la incidencia en estas últimas. La quimioterapia es el tratamiento más utilizado y frecuentemente viene acompañada de efectos secundarios nocivos para el organismo. Con el fin de minimizar estos efectos, se ha explorado el potencial quimiopreventivo de compuestos naturales, descubriendo que pueden actuar sobre el proceso de transformación maligna y ser efectivos en la prevención y detención de la progresión del cáncer, generando beneficios en la salud con baja toxicidad y costo [1]. La uva es una de las frutas más ricas en polifenoles, caracterizados por poseer propiedades biológicas, en las que se incluyen actividad antioxidante, antiinflamatoria, anticancerígena, antimicrobiana, antiviral y son modificadores selectivos del receptor de estrógeno, lo cual las hace relevantes para carcinomas hormonales como el de mama [2],[5]. En este estudio, exploramos el potencial quimiopreventivo de la uva Isabella sobre la línea celular MCF-7, con el fin de evaluar su potencial antitumoral. El extracto de uva se preparó previamente a partir de uva Isabella obtenida comercialmente. Brevemente, la extracción se realizó por sonicación empleando diferentes frecuencias y mezcla de solvente agua:etanol. Como modelo celular tumoral se empleó la línea celular MCF-7 de cáncer de mama, las células se mantuvieron bajo condiciones normales de cultivo; para los tratamientos se emplearon cultivos exponenciales que fueron expuestos por 24 horas a diferentes concentraciones del extracto. Para determinar el efecto citotóxico se empleó el ensayo colorimétrico MTT y se realizó seguimiento a los cambios morfológicos empleando microscopía. Los resultados preliminares muestran disminución en la viabilidad de las células de cáncer de mama MCF-7 de una forma dependiente de la dosis con diferencias estadísticamente significativas a concentraciones mayores de 500 µg/mL. Estos datos evidencian el potencial de la uva Isabella como agente quimiopreventivo; sin embargo, hasta el momento no se sabe cuál es el me-

canismo biológico por el cual el extracto induce la muerte celular. Estudios realizados por otros investigadores han demostrado que extractos de uva del género *Vitis* inhiben el crecimiento de células de cáncer de mama, debido al efecto de los polifenoles sobre las especies reactivas de oxígeno e inducción a apoptosis [6], [7]. Por otro lado, los cambios morfológicos que presentan las células en respuesta al tratamiento son característicos de células en apoptosis temprana, pues exhiben aumentos significativos en la forma superficial y grado de irregularidad [8]. Estudios adicionales son necesarios para definir el efecto biológico que induce a la pérdida de viabilidad celular. Adicionalmente, replicar los experimentos con una línea celular no tumoral permitiría estudiar el efecto selectivo de los extractos sobre células de cáncer.

ID: 76

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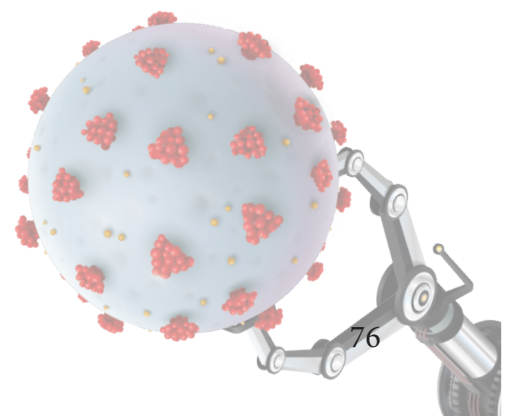
Dinámica Cardiovascular

Computational model of venous section for flow analysis in patients with ventriculo-atrial shunts.

Jose M. Abril-Nova and Diana A. Espitia-Cortés

Ventriculo-atrial shunts accounts for the second most common type of treatment for hydrocephalus patients who require an external CSF drainage. However, the effects of this treatment on cardiac hydrodynamics have not been researched enough. Thus, this work address the treatment trough the development of a computational model of a venous section to evaluate the effect of the catheter for ventriculo-atrial drainage on venous hydrodynamics. Thereby, having a better understanding of the effects, allowing in the future to offer better treatment guidance. Through this model, hydrodynamic disturbances were observed on the flow, pressures and mostly flow velocity. This disturbances were present mostly in the zone adjacent to the catheter insertion, on the internal jugular vein.

ID: 105



Anal  sis de Cardiopat  as Cong  nitas por M  todo de Elementos Finitos

Juan Pablo Orozco   vila, Paola Andrea D  az Mart  nez and Ang  lica Mar  a Ram  rez Mart  nez

Las malformaciones card  acas son la segunda causa de muerte m  s com  n en reci  n nacidos, con alrededor de 270 mil fallecidos menores a 28 d  as de vida [1]. Debido a la dificultad de la medici  n directa de los perfiles hemodin  micos que se presentan en los vasos sangu  neos a causa de las enfermedades cong  nitas, se ha aceptado las simulaciones de la din  mica computacional de fluido CFD como una herramienta de apoyo cl  nico para el entendimiento del aneurisma craneal [2] o enfermedad de Fontan [3]. Con base en esta aproximaci  n, el objetivo de este estudio es caracterizar la hemodin  mica local en los vasos principales del coraz  n, a partir de una geometr  a generalizada, para diferentes cardiopat  as cong  nitas a trav  s de una simulaci  n de CFD. Se plantea un an  lisis de las cardiopat  as cong  nitas (atresia pulmonar y conducto arterial persistente). Para la geometr  a se definen las dimensiones de las cavidades ventriculares, las arterias pulmonar y aorta de acuerdo a los propuesto por [4] (ver Figura 1). Se estudia el flujo de sangre dentro de las cavidades con las siguientes propiedades mec  nicas: densidad 1050 kg m^{-3} y viscosidad 0.0035 Pa s . La malla del flujo continuo de tipo tetra  drica, con un total de 232837 elementos. El an  lisis consiste en comparar las presiones y velocidades arteriales entre la geometr  a de un coraz  n sano y la geometr  a de cada cardiopat  a. Para todos los casos se usa como condiciones de contorno los valores de presi  n normalmente ejercidas durante la s  stole ventricular (ventr  culo derecho: 25 mmHg; ventr  culo izquierdo 120 mmHg). En las porciones finales de las arterias pulmonares y aorta se emplearon una presi  n de 21 mmHg y 110 mmHg respectivamente [8]. El modelo se valida con los resultados del coraz  n sano, para el que se logran los valores de presi  n arterial normales de 113 mmHg para la arteria aorta y 22 mmHg para la arteria pulmonar [6]. Asimismo, para las velocidades se obtienen resultados de 1.19 m/s en la aorta descendente y 0.65 m/s en la arteria pulmonar, consistente con los rangos normales de literatura [7]. En la simulaci  n del escenario del conducto arterial persistente (Figura 2a), en el que se presenta comunicaci  n entre el cayado de la aorta y la arteria pulmonar derecha, se observ   un intercambio de sangre en direcci  n a la arteria pulmonar, dado por la presi  n mayor en el ventr  culo izquierdo. La

velocidad y presi  n disminuyen en la aorta ascendente en comparaci  n al coraz  n normal llegando hasta 1.02 m/s y 102 mmHg respectivamente. Contrariamente, en las arterias pulmonares, se encuentra un aumento de la velocidad y la presi  n, llegando hasta los 1.5 m/s y 26.31 mmHg a ra  z de la entrada anormal de sangre que alcanza los 5 m/s en el vaso de comunicaci  n. En el escenario de la atresia pulmonar (Figura 2b) se presenta una estenosis pulmonar y una comunicaci  n entre el cayado de la aorta y la arteria pulmonar. Se obtuvieron resultados de presiones en la aorta de 97.76 mmHg y 25.84 mmHg para la arteria pulmonar. En cuanto a velocidades, se encuentran valores de 2.3 m/s en la aorta ascendente y 1.34 m/s en la arteria pulmonar. Adem  s, se observa una magnitud de 4.5 m/s justo en el canal que une ambas arterias. Dentro de las cardiopat  as analizadas, se observa que existe un aumento de velocidades en los vasos sangu  neos, por consiguiente, que a largo plazo, puede generar hipotensi  n, afectando los   rganos adyacentes [8].

ID: 58

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Dispositivos Médicos

Development of a wearable system with In-Ear EEG electrodes for the monitoring of brain activities: An application to epilepsy

José Juez, David Henao, Fredy Segura, Rodrigo Gómez, Michel Le Van Quyen and Mario Valderrama

Epilepsy is a chronic noncommunicable disease of the brain characterized by recurrent seizures, which are brief episodes of excessive and synchronized electrical discharges of neuronal activities. The main technique used for the diagnosis of seizures is the electroencephalography (EEG), a noninvasive method which records the electrical activity of the brain. The conventional EEG monitoring to diagnose epilepsy has some problems: First, the short monitoring time generates misdiagnosis. Second, the long wires needed for the connection of electrodes are uncomfortable for the patients. Third, the patients are not monitored in a natural environment where different conditions can trigger seizures and last, a conventional EEG monitoring is too expensive. A solution is the development of a wearable monitoring EEG where the recording system is a device of small dimensions with continuous and long-term recording capabilities. In this work, we developed an In-Ear wearable system to allow a long-term recording of EEG signals in a nonclinical environment. For this, we designed In-ear electrodes with soft foam earplugs and a knit conductive fabric of silver. We performed different tests to validate the signal quality of the acquisition system including one ambulatory recording in an epileptic patient.

ID: 91

ProteSOS: A MHealth System for Improving Coverage of the Prosthetics and Amputees Unit at the Central Military Hospital

Ana Maria Velosa-Orduz, Diego Alejandro Solano-Ariza, Mario Linares-Vásquez, Miguel Ángel Gutiérrez, Juan Pablo Borrero, Daniela Vega, Rodrigo Gómez-Martínez and David Bigio

Due to the armed conflict in Colombia, the Central Military Hospital (HOMIL) attends more than 2000 lower limb amputee patients nationwide. These patients are attended by the Amputee and Prosthetics Unit (UPA) within the Hospital or by means of a Workshop Car in different rural areas of the country, attending "Brigadas". The attention given to these patients in rural areas, although very good, tends to be a delayed process and with little communication between patients and professionals. Therefore, we designed a user-centered M-Health system (called ProteSOS), that is expected to reduce patient care times and improve communication between amputees and HOMIL's professionals. In the paper, we describe the design and development process of the system and preliminary user validations.

ID: 73



SARMaware: the future of the detection of methicillin-resistant *Staphylococcus aureus* in infected wounds

María Andrea Pedraza Martínez, Laura Sofía Mora Benavides, María Ximena Forero Farias, Alejandra María Espitia Posada, Juan David Martínez Plata and David Bigio Roitman

Among nosocomial infections, one with the highest mortality and contagion rate worldwide is caused by methicillin-resistant *Staphylococcus aureus*, also known as MRSA. These strains are resistant to multiple broad-spectrum antibiotics that are often prescribed when the type of microorganism causing the infection is unknown. Although there are methods to detect MRSA, they are only performed in laboratories by trained professionals. Likewise, less expensive detection techniques give results in more than 12 hours. During this period of time the bacteria has already begun to develop stronger resistance mechanisms and, even, has compromised multiple organs and tissues of the patient. Now, there are rapid detection methods, but these are very expensive, so not all health institutions can afford them. The SARMaware project was initiated due to all of these health, medical and economical issues. This project focuses on the development of a fast, efficient and low-cost technique that can detect the presence of MRSA in infected wounds. In this article, initial fabrication and standardization steps of a paperbased microfluidic device with hydrophobic channels designed using laser printing techniques are evaluated. The main objective is to propose a standardized synthesis of a portable device that can detect MRSA from wound swabs using anthocyanins from purple cabbage as a pH indicator. Up to now, the standard procedure for anthocyanin extraction has been designed and evaluated, as well as the optimal morphology of the channels printed on the paper device according to parameters such as channel width and sample's flow time. It is clear, however, that more tests are necessary to fully address the proposed device's function and range of operation. However, these experimental results are promising, meaning that SARMaware has potential as a rapid and economic alternative for MRSA detection in a clinical environment.

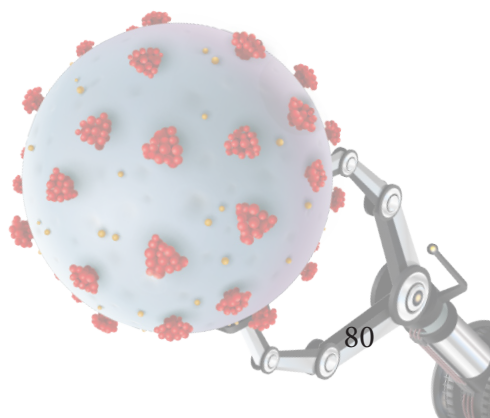
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Alternative Tool for the Diagnosis of Diseases Through Virtual Reality

Miguel Esteban Mora Gonzalez, Sara Daniela Galeano Galeano and Ricardo Alonso Espinosa Medina

Virtual reality (VR) presents objects or simulated scenes to reproduce situations in a way similar to the real thing. In medicine, processing and 3D reconstruction of medical images is an important step in VR. We propose a methodology for processing medical images, to segment organs, reconstruct structures in 3D and represent structures in a VR environment, in order to provide the specialist with an alternative tool for the analysis of medical images. We present a method of image segmentation based on area differentiation and other image processing techniques; the 3D reconstruction was by the 'isosurface' method. Different studies show the benefits of VR applied to clinical practice, adding its uses as an educational tool. A VR environment was created to be visualized with glasses for this purpose, this can be an alternative tool in the identification and visualization of COVID-19 affected lungs through medical image processing and subsequent 3D reconstruction.

ID: 116



Innovación en el Desarrollo de Dispositivos Médicos de Bajo Costo en Colombia: Diseño y Evaluación de una Bolsa de Morcelación para Cirugía Laparoscópica Ginecológica

Fernando Gómez Corredor, Alejandra Riveros and Juan C. Briceño

La cirugía laparoscópica es una técnica generadora de impactos positivos en el Sistema de Salud de Colombia al disminuir riesgos durante y posterior a la intervención quirúrgica, al reducir los tiempos de recuperación y de estancia hospitalaria y al disminuir los costos de incapacidad. En la medida en la que esta técnica sea difundida como alternativa quirúrgica ginecológica viable, sus impactos serán mayores beneficiando particularmente a las poblaciones femeninas más vulnerables del país. La FDA indicó en el año 2014, que se debe limitar el uso de las cirugías mínimamente invasivas si no se cuenta con una atmósfera cerrada, es decir, morcelación contenida en bolsa, dado el alto riesgo de contaminación de la cavidad abdominal por diseminación de células malignas [1]. En el año 2016 se desarrolló el PneumoLiner, dispositivo de contención de tejidos que fue aprobado por la FDA en el 2019. Este dispositivo médico permitió realizar la extracción del tejido con bolsa de contención utilizando laparoscopia. Sin embargo, el costo de una Bolsa de Morcelación de uso comercial es superior a 600 USD [3], lo cual incrementa los costos totales del procedimiento quirúrgico. De acuerdo con el Ministerio de Salud, de 339 hospitales y clínicas en Colombia se estima que tan solo el 30% de estos centros cuenta con los recursos para realizar cirugías laparoscópicas [4]. Este proyecto tiene como objetivo aplicar las estrategias de biodiseño y traslación clínica para el desarrollo de una bolsa de morcelación para contención de tejido de costo asequible para el sistema de salud colombiano que garantice la no contaminación de la cavidad abdominal al cumplir con la observación de la FDA y que preserve los beneficios de la cirugía mínimamente invasiva en la cirugía ginecológica. El desarrollo de la bolsa

constó de dos fases: la primera asociada a la definición del material, diseño, ergonomía para ser usado en cirugía y estrategia de manufactura y la segunda enfocada a la evaluación de la biocompatibilidad del prototipo estabilizado bajo normas y requerimientos regulatorios del INVIMA. Se realizó un proceso iterativo para selección del prototipo haciendo uso de diseño asistido por computador en el software Autodesk Inventor 2020, prototipado físico y pruebas de evaluación de biocompatibilidad bajo estándares ISO 10993. Se realizó un estudio de materiales aprobados para dispositivos médicos de uso intracorpóreo o en contacto con tejidos. Se sometieron los prototipos y materiales a un modelo de falla para evaluación e iteración en los diseños con las modificaciones acorde a las fallas identificadas en los prototipos previos. Se determinó que las hojas de PVC de calibre 80 permitían su apropiada adhesión con ciclohexanona en términos de facilidad de manufactura y reportes de uso previo para bolsas de uso médico. Adicionalmente, el calibre seleccionado permitió cumplir con las restricciones de diseño espaciales en términos de la introducción de la bolsa a una cavidad de 12mm, memoria de forma del material para su extrusión al interior de la cavidad abdominal y resistencia mecánica del material ante punción, tensión y presión al estallido. Se realizaron pruebas de biocompatibilidad exigidas por el estándar internacional ISO 10993 dentro de las cuales se encuentran hemólisis, agregación plaquetaria, citotoxicidad directa e indirecta y evaluación de la resistencia a tensión. Se determinó que el porcentaje de hemólisis del PVC y PVC+ciclohexanona es inferior al 2% para ambos grupos muestrales. La agregación plaquetaria de los grupos muestrales fue cercana al 50% respecto al control positivo de epinefrina. Las pruebas de caracterización mecánica indicaron que las probetas de PVC adheridas con ciclohexanona soportan más de 5 N y 10 mm de desplazamiento bajo tensión. Los resultados obtenidos sugieren que el material seleccionado cumple con propiedades de biocompatibilidad y de usabilidad aplicables al desarrollo del dispositivo médico en cuestión. Se obtuvo un prototipo estabilizado del dispositivo médico el cual pasará a fase de evaluación de in vivo y ensayo clínico.

ID: 99



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Estenosis benigna de la anastomosis biliar en pacientes con trasplante hepático: comparación de soluciones actuales

Manuela Rodríguez, Juan Briceño, Juan Pérez, Camila Castro and Miguel Prieto

Diferentes afecciones hepáticas requieren como tratamiento un trasplante de hígado, entre ellas la enfermedad hepática terminal de pacientes pediátricos. Esta es la práctica clínica común, puesto que ha demostrado resultados positivos en la supervivencia de los pacientes e injertos [1]. Para dimensionar esta situación, se estima que en EE. UU durante el 2017 se realizaron 8000 trasplantes de hígado en adultos y niños, mientras que la lista de espera para trasplante hepático registró 11.500 personas nuevas [2]. Cerca del 10% de los pacientes en las listas de espera a nivel mundial son pacientes pediátricos [3]. Una complicación que se presenta en alrededor de un tercio de los pacientes es la estenosis benigna de la anastomosis biliar. Esta condición clínica requiere un pronto manejo, ya que de persistir puede generar daño hepático irreversible como fibrosis o cirrosis secundaria e hipertensión portal [4]. Como consecuencia de estas complicaciones, se presenta insuficiencia hepática, que es un factor de riesgo relacionado con morbilidad y mortalidad posterior a la reparación de las vías biliares [4]. Algunos estudios reportan que la estenosis benigna de la vía biliar puede relacionarse en la mitad de los casos con las complicaciones quirúrgicas durante el procedimiento [5]. El manejo clínico percutáneo de la anastomosis, consiste en una derivación biliar con dilataciones progresivas del sitio de estenosis empleando catéter balón y diferentes catéteres de drenaje, con un aumento progresivo del diámetro del catéter cada 2 semanas desde 8F hasta un diámetro final de 22F. Esto implica realizar múltiples intervenciones. En este trabajo se realizó una revisión bibliográfica, incluyendo patentes, artículos científicos, y experiencias clínicas con los elementos y procedimientos empleados actualmente y las tecnologías emergentes para hacer frente a esta condición, con el fin de comparar sus ventajas y desventajas.

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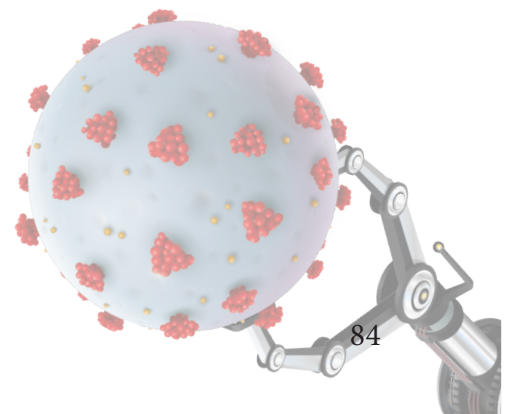
Genética

A free-software educational tool for modeling gene expression in cell populations

Brayam Andres Saavedra and Andres Mauricio Gonzalez-Vargas

Biochemical reactions that take place inside cells can be modeled and approximated in a practical way through differential equations. In silico, it is possible to study biological process behaviors such as the difference in gene expression levels of a protein throughout a homogenous cell population. Computational methods are used to model, simulate, and infer such behavior. The implementation of this kind of methods requires having good knowledge of the biology involved and the algorithms to approximate its behavior. In this paper, we propose a tool for modeling gene expression of cell populations. Firstly, fundamental aspects of the biological system paradigm are gathered to present a graphical user interface that integrates some algorithms relevant to introduce beginners to the field. The interface could help students to obtain insights about basic topics on biological system definition, simulating from several variability sources and parameter identification. Free open-source software is used to ensure accessibility to the tool and its potential modification, enhancement, or usage of the implemented algorithms.

ID: 20



Delivery of CRISPR/Cas9 Editing Systems for the Treatment of Idiopathic Parkinson's

David Arango, Tatiana Beltrán, Carolina Muñoz-Camargo, Luis Reyes, Juan Carlos Cruz and Natasha Bloch

Gene therapy represents a disease-modifying alternative to palliative treatments for neurodegenerative diseases (e.g., Parkinson's, Alzheimer's, and Huntington's diseases) [1]-[3]. Idiopathic Parkinson's has been linked to genetic mutations in GDNF, PRKN, and PINK-1 genes among others, associated with the Parkinsonian characteristic symptomatology [4]. Over the years, several gene therapy strategies have been introduced, albeit still with considerable limitations. CRISPR/Cas9 offers several advantages for gene editing, including ease of implementation, versatility, and high-fidelity editing. Success of CRISPR/Cas9 therapy is strongly dependent on the delivery strategy of the various components without inducing significant immune responses while maintaining high bioavailability levels [5]-[7]. An attractive route for improving the delivery efficacy is by transporting the gene cargoes aided by nanocarriers. Popular vehicles in this family include metallic nanoparticles, carbon-based nanomaterials, and lipid-based nanostructures. Our research group has dedicated significant effort to developing a nanoplatform for nucleotide delivery based on modified magnetite nanoparticles, which are attractive due to their strong magnetic responsiveness to guide the nanovehicles to the site of action [8]. These delivery carriers contain a disulfide bond (pH-sensitive) and a efficient translocating protein (OmpA) to facilitate internalization and promote endosomal escape [9]. Magnetic nanoparticles synthesis is based on a co-precipitation method described in previous work [8]. After synthesis, nanoparticles are silanized to obtain a functional amino group on the surface that enables a conjugation with OmpA, PEG, and AEDP linkers and obtain the preceding specified characteristics. A plasmid containing sequences for both dCas9 nuclease and sgRNA (targeting the prior mentioned genes) was designed and conjugated by a disulfide bond formation to the nanoparticles aided by a short thiolated sequence. Since AEDP linker contains a

disulfide bond, and under a provisional reducing environment a bond between nanoparticles and thiolated sequence is created. Neurons' cytosol provides an environment where the disulfide bond is reduced to promote the CRISPR plasmid delivery. As a proof-of-concept experiment, we performed in vitro delivery of a conjugated Rhodamine-labeled cysteine and confirmed delivery of 86% of the loaded material after two hours, under reducing conditions given by DTT. Moreover, experiments in neuroblastoma cells revealed high endosome escape levels as evidenced by colocalization with Lysotracker below 11%. Future work will focus on testing genome editing in vitro in neuroblastoma, primary human astrocytes, and glial cell lines. Although the present work is still in progress, the developed delivery carrier has characteristics that enable endosome escape, the liberation of genetic material into the cell cytoplasm, and spatially control with magnetic fields. Therefore, this study will impact not only Parkinson's disease but other genetic diseases by offering an efficient treatment alternative [10].

ID: 1

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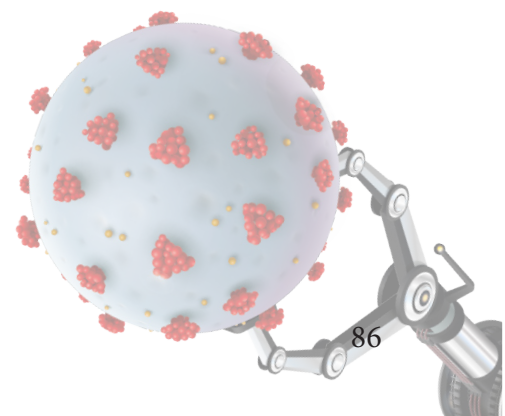
Differential effects of acute stress on young and old zebrafish behavior and regeneration

Angie Henriquez Martínez, Natasha Ivonne Bloch Morel, Veronica Akle Alvarez, Laura Catalina Avila Matallana and Maria Antonia Pulido Martínez

Stress can have a significant impact on many aspects of an organism's physiology and behavior. Environmental stimuli such as daily routine, dietary habits and stress are strongly related to the physiology of our body. However, the relationship between stress and regeneration and how it is mediated remains poorly understood. The zebrafish has been used as a promising model in behavior, stress, anxiety and neuroscience research, due to its homology with vertebrates like rodents and mammals. Here we investigate how stress impacts behavior and regeneration, and how this relationship changes with age in zebrafish (*Danio rerio*). Animals were pooled and randomly assigned to two experimental groups: control and stress in both age groups, young adult and mature adult. The fish were maintained in standard conditions, but the stress group was exposed to unpredictable chronic stress protocol (UCS). All animals were individually submitted to behavioral tests (open field and light/dark preference) before and after the UCS protocol, both control and stress, to evaluate anxiety-like behavior. In the open field test we analyzed the distance to the center of the arena, the total distance moved and the average velocity of the fish to characterize their behavior. Additionally, in the light/dark preference test we measured the number of transitions between white and black zones and the total time the fish remained in the white zone. After eight days of UCS protocol exposition, we cut the lower part of the caudal fin in all animals to study the effect of the stress on tissue regeneration. We registered the growth of the caudal fin every three days (on days 13,16,19 and 23). In the regeneration test we calculate a regeneration factor dividing the length of the regenerated tissue by the original length of the caudal fin. Finally, we studied expression of two genes (*sam2* y *nlgn1*) associated with anxiogenic behavior. We found mature adult and young adult fish are differentially impacted by stress, as mature fish regenerate their caudal fin significantly slower after UCS protocol. Even though

we observed regeneration in the control group and in the stress group in both age groups, the length of the regenerated tissue in the stressed group was significantly shorter than the length of the tissue in the control group in mature adult fish. Our findings imply chronic stress decreases mature fish's ability to regenerate after injury. On the contrary, this effect was absent in young adult suggesting stress does not impact their regeneration capacity. On the other hand, we found no significant differences in the effect of stress on behavior between the two age groups, but we observed a significant difference in the behavior parameters in stressed young adult fish before and after the UCS protocol. This effect in behavior was absent in the stressed mature adult fish showing a stronger effect of stress in behavior for young adult fish and a stronger effect of the stress in regeneration for mature adult fish. In addition to these results, we observed significant differences between the expression levels of *sam2* within the experimental groups. Mature stressed fish showed higher expression levels of the gene compared to control fish; we could not identify significant difference in the expression levels of the *nlgn1* gene. These results suggest a close relationship between chronic stress, regeneration, and behavior in zebrafish (*Danio rerio*), and also show an impact of stress on physiological processes changes with age.

ID: 2



NLRP3 Inflammasome: Potential role on radiation dermatitis in breast cancer patients

Juanita Monje, Juan Sebastián Nieto, Erika Díaz, Mónica Gantiva, Juliana Casas, José Moreno, Juan C. Cruz and Carolina Muñoz-Camargo

Radiation therapy is one of the 3 main general treatment options for cancer patients, along with surgery and chemotherapy. Radiation dermatitis (RD) is considered the most common side effect, with reports of presentation in up to 95% of patients suffering from different types of cancer such as head and neck, prostate and breast cancer [1]. RD has been classified according to the grade of severity (grade 1 through grade 4) and varies between mild erythema with desquamation to moist desquamation and even ulceration [2]. Radiation therapy is advised to be suspended generally with grade 2 lesions or above until skin recovery, in spite of the consequences in the prognosis of the patient's disease [3]. RD grades of severity can also be associated with several risk factors such as previous skin disease, type of cancer, radiation dose, and genetic factors, among many others [2,4,5]. Particularly in breast cancer, genetic polymorphisms such as XRCC1, XRCC3, XPD, MLH1, MSH2 have been reported to be related RD occurrence [6]. Recently, the NLRP1 gene has been associated with skin response to radiation while NLRP3 has been linked to skin pathologies such as atopic dermatitis [7,9]. These genes belong to NLRP inflammasome family, which activates in response to endogenous signals mediated by DAMPS (Damage Associated Molecular Patterns) and exogenous signals mediated by PAMPs (pathogen associated molecular patterns) [8]. Based on such previous reports, we developed a genetic map showing association between the NLRP3 gene and the proteins DHX33, CARD8, USP50 and P2RY2 to explore their possible correlation with skin inflammatory diseases. Given this association of genes from the NLRP family with skin pathologies, the objective of this study was to identify whether the NLRP3 gene is involved in the pathophysiological development of RD in breast cancer. We conducted a search on GeneCards (The Human Gene Database) with keywords "Radiation Dermatitis" and "Radiodermatitis" to obtain a list of the genes possibly related to RD.

We uploaded the obtained list to the IMEx (International Molecular Exchange Consortium) platform to find molecular interactions between the genes and NLRP3. Next, we used Cytoscape to visualize and analyze the identified interactions in IMEx and created a gene map for NLRP3 and RD's genes. As search parameters we took into account the relevance score (RS), which is the ratio between the direct interactions of a protein with the protein of interest and its total interactions, where RS= 0 represents all possible interactions and RS=1 those that are only with the protein of interest. We obtained a list of 42 genes related with RD such as BRAF, RAD51, XRCC3 and their corresponding relevance scores with 17 of them reaching RS above 0.5. Among others, this list included TP53, XRCC4, BRAF, RAD51, and was later uploaded to the IMEx platform to obtain 1,541 binary interactions for the 42 genes and NLRP3. As expected, results of the Cytoscape mapping led to a genetic network for NLRP3 and RD's genes, with RS above 0.5 in certain pathways that allowed us to confirm the influence of NLRP3 on the network responsible for RD's pathophysiology. The identified role for NLRP3 will be explored experimentally with molecular biology tools on in vitro 2D and 3D bioprinted human skin models exposed to standardized doses of radiation.

ID: 12

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Reconocimiento de la ancestralidad basado en modelos de agrupamiento probabilístico no lineal utilizando Polimorfismos de un solo Nucleótido de individuos con ascendencia mezclada

Javier Andrés Sierra Pineda, Hernán Felipe García Arias and Gloria Liliana Porras Hurtado

América es el continente que presenta el trasfondo genético ancestral más variado y complejo en la actualidad, debido al proceso de mezcla y recorrido poblacional que ha sufrido a lo largo de los años. Este recorrido poblacional o reconocimiento de la ascendencia es una aplicación de las ciencias genómicas en donde a partir de marcadores informativos de ascendencia (AIM) se extraen características y propiedades genéticas con la finalidad de establecer la composición ancestral de individuos, determinando el porcentaje de ascendencia perteneciente a cada una de las poblaciones de muestra [1]. Desde el área del aprendizaje automático se han desarrollado numerosas investigaciones que permiten abordar el reto de estimar la ascendencia de individuos a través de polimorfismos de un solo nucleótido (SNP) por medio de modelos de aprendizaje supervisado como lo son la clasificación por árboles de decisión[2][3] y Naive Bayes[4]. Los cuales, a pesar del cumplimiento del objetivo de reconocimiento ancestral que plantean, presentan bastantes limitantes en su diseño, como ser métodos totalmente supervisados y enfocarse en análisis lineales de las componentes de las características de los datos, dando errores a la hora de clasificar los individuos, traduciéndose en la disminución del porcentaje de precisión del modelo. Por lo cual, en este proyecto se propone desarrollar un nuevo enfoque para estimar el porcentaje de ascendencia de individuos a partir de SNP's basado en modelos de agrupamiento probabilísticos no lineales, una técnica que combina herramientas del aprendizaje no supervisado. El enfoque desarrollado presenta la ventaja de modelar un nuevo espacio de características de relación no lineal, de menor dimensionalidad, pero altamente separable con la mayor información posible de los datos reales a partir del análisis de componentes principales por kernel [5]. Con el nuevo espacio de características obtenido, es posible emplear métodos de agrupamiento probabilísticos como las mezclas de Gaussianas, las cuales tienen como característica principal permitir agrupar los

datos según el porcentaje de pertenencia a cada clase, conociendo así que tanta probabilidad tiene la muestra de pertenecer a un grupo u al otro [6]. Las muestras utilizadas en este estudio son extraídas de la base de datos PIMA+34plex GENOTYPES del estudio de C. C. Gontijo et al [1] basado en el proyecto 100 Genomas y el proyecto de Diversidad del Genoma Humano. La cual contiene 57 SNP pertenecientes a individuos de 19 poblaciones diferentes con sus respectivas etiquetas. El modelo de agrupamiento desarrollado se encuentra basado en métodos paramétricos los cuales necesitan la elección correcta de sus variables para tener el mejor resultado posible, por esto es necesario sintonizar los hiperparámetros de forma manual y medir su desempeño con cada elección. Los valores óptimos encontrados se presentan mediante una función de kernel sigmoidal y un número de componentes principales igual a 2, arrojando resultados al agrupar individuos de poblaciones puras con valores de 95.23% y 93.78% entorno a métricas de evaluación como el índice Rand ajustado y la puntuación basada en información mutua. Con el modelo ya sintonizado y entrenado, es posible inferir agrupaciones en marcos probabilísticos de pertenencia, obteniendo resultados satisfactorios al analizar diversas mezclas poblacionales, en particular Awa, Mulalo y Brasil, las cuales presentan un alto interés en el estudio que se encuentra basado ya que demuestran el fuerte impacto de la migración que se ha presentado en estas poblaciones y regiones, por ejemplo en los individuos brasileños y mulalos donde se resalta el alto impacto que tenido los procesos de mezcla de africanos y europeos en sus orígenes, en cambio los Awa se consideran como una población nativo-americana pura. Los resultados obtenidos muestran que el modelo propuesto estima con precisión la ancestralidad de individuos con ascendencia mezclada.

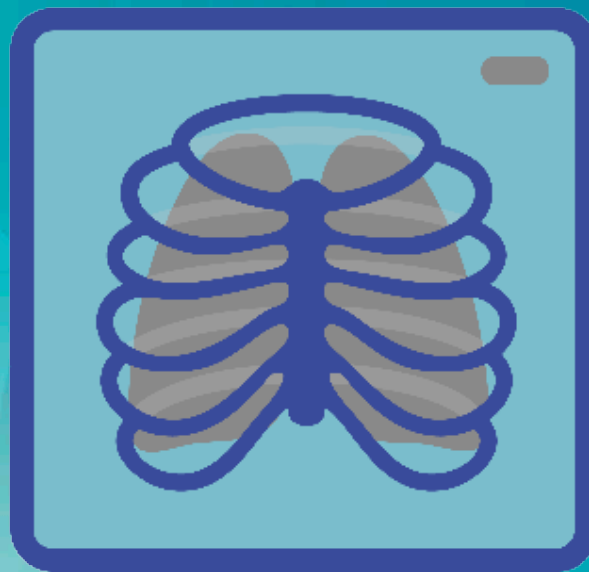
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Imágenes Biomédicas

Software application: Diffusion weighted imaging parameters to explore new insights into Parkinson's Disease

Gloria Cruz

Parkinson's disease is a progressive, degenerative neurological condition, which origin remains unclear. Assuming the hypothesis that microcirculatory disturbances suggest possible impairments that affect the neural activity causing the progressive death of neurons in the substance nigra; based on findings that demonstrated relative hypoactivity located to basal ganglia, and particular diffusivity and anisotropy measures in regions that are characterized by the degeneration of the dopaminergic neurons. Incoherent motion intravoxel and diffusional kurtosis imaging are valuable methods in studying that have still to explore, in order to approach to understand the alterations that could be significant in Parkinson's disease. This paper proposes an image-J tool, useful to investigate the changes in microvascular level in substance nigra, and vascularization evidenced by reticulin staining in the zona compacta which could be reflected by quantification of tissue structure provided by non-Gaussian diffusion. Also, some preliminary parameters obtained from a normal volunteer show high correlation between perfusion and kurtosis in the midbrain. These parameters provide possibility Parkinson's disease biomarkers in future studies.

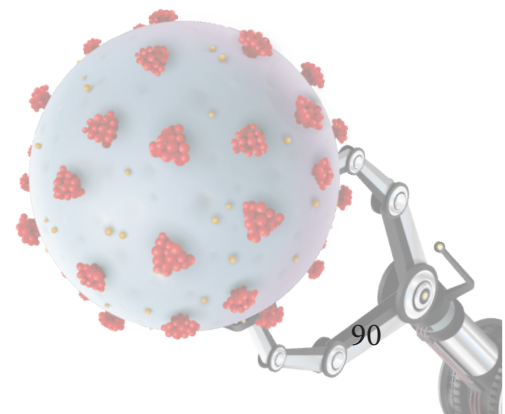
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Using MRI to determine anatomic differences of the lateral geniculate nucleus in subjects with dyslexia

Carlos Andrés Ferro, David Ricardo Ortigoza, Mónica Giraldo-Chica and Andres Mauricio Gonzalez-Vargas

The analysis of pathologies that affect learning processes over time has allowed the creation of different theories, which seek to explain dyslexia and its causes in the brain. The implementation of image processing techniques in this research field has made it possible to advance in the investigation of the different phenomena and anatomical structures involved in the learning processes. One of the techniques is tractography, which allows evaluating the connection of different areas of the brain and evaluating possible shortcomings or disconnections in different areas of the brain. The magnocellular theory suggests that the lack of connection of the cells of the magnocellular pathway in the LGN, which are part of the visual system of the human brain, are diminished in dyslexic patients, which would be a possible cause of cognitive functional deficiencies. This work seeks to evaluate the differences between a control and dyslexic subjects, by using MRI images.

ID: 17



ImageJ software performance analysis to determine the laterality index

Narlen Daniela Carvajal Arias, Ricardo Andres Toscano Villamizar, Angela Patricia Morales Salcedo and Manuel Hernando Franco Arias

The calculation of the hemispheric laterality is a method that has increased its use by health professionals and research groups related to the field of functional brain activity. The implementation of this is done through technology guided to design and obtain the Regions of Interest (ROIs) for the subsequent calculation of the Laterality Index. In pursuit of knowing many tools that allows the development of this technique, was tested the free access software ImageJ to calculate the laterality index defining the ROI in the same application. The software tests were performed with functional magnetic resonance images (fMRI) images of NITRC for the frames, with binary images for the functional test performing the end-to-end calculation and, subsequently, to test its performance in the field, 7 fMRI from the ADNI database were used, the study allowed us to determine the quantification of the ROIs, drawing manually and the error that maybe has. All the test results showed a good overview of the software in the research and hospital applications having a small error in the quantification of the ROIs largely caused for human mistakes. Finally, these results allow to validate the correct operation of the application.

ID: 28

Ocular fundus image classification for retinopathy diagnosis

Manuel Gallegos, Nicolás Mora, Sabina Nieto and Pamela Ramírez

Silent diseases are those which symptoms are difficult to detect in early stages, for this reason, in most cases this type of diseases are detected when their treatment is very complex and risky. However, they can change the eye appearance as the disease progresses. Therefore, the development of an algorithm able to detect silent diseases based on ocular fundus images is relevant to give appropriate treatment. This paper presents the classification of normal ocular fundus (control class) and three silent diseases: glaucoma, pathological myopia, and cataracts. These classification classes were selected because they present the most significant differences between each other in ocular fundus images. In order to make the results more accurate, it was necessary to use images with the same format, and so, the images were preprocessed. After having performed a robust set of experiments for the classification methods and descriptors, the best performing method was SVM, as the classification method, combined with HOG, as the descriptor. The final method had a precision of 0.61, a recall of 0.477 and an F-score of 0.517. In conclusion, the developed method showed some difficulties classifying glaucoma, however, the classification of pathological myopia seems to be appropriate compared with methods found in literature

ID: 30



Body hair noise suppression in skin lesions by differential operator and maximum variance threshold between classes

Carlos Vicente Niño Rondón, Diego Andrés Castellano Carvajal, Byron Medina Delgado, Sergio Alexander Castro Casadiego and Dinael Guevara Ibarra

Dermoscopic images allow to visualize with emphasis sections of the skin in which lesions are presumed. In these images it is common to find sections of body hair that represent noise in the analysis of the section for the treatment and diagnosis of skin cancer. In this work we present a proposal for the enhancement of the skin lesion of interest in dermoscopic images with abundant body hair over the lesion. The proposal is based on close-up visualization of the lesion of interest, by processing the image using a differential operator for edge detection, accompanied by a maximum variance threshold between classes for skin lesion detection. Tests were performed on images from the ISIC Challenge Dataset, and an average skin lesion size preservation rate of 93.852% and total body hair removal was determined for more than 80% of the images tested. The proposed method showed robustness to images of different sizes and pigmentation and can be considered as a support tool in computer-aided diagnosis processes for the treatment of skin lesions.

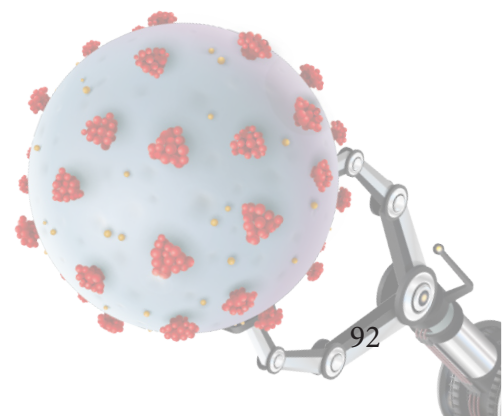
ID: 33

ROG for biomedical semantic segmentation of lung cancer tumors.

Felipe Escallón Páez and Jose M. Abril-Nova

Lung cancer causes the higher number of deaths each year of any type of cancer. Generally this cancer is detected when no possible to perform an effective treatment and the usage of computational methods for segmentation can improve the time to initiate this treatments. The medical segmentation decathlon is a challenge to do a generic segmentation method for 11 different tasks. However, the current methods have poor results on the lung nodule segmentation task. This work focuses on implementing changes made by state of the art methods in lung nodule segmentation to the network developed by the Biomedical Computer Vision group from the Universidad de los Andes for the challenge. All of this reducing the computational cost of the network. The final network implemented, a deeper model of the original referred to as ROG+ reduce significantly the computational cost of the method while maintaining similar but lower metrics with a 27.58% dice score.

ID: 40



Quality Enhancement of Breast DCE-MRI Images Via Convolutional Autoencoders

Pablo Campaz Usuga, Ruben Dario Fon-negra Tarazona and Carlos Andrés Mera Banguero

Magnetic Resonance Imaging (MRI) is a technique used in medicine to visualize interior body structures in order to diagnose a variety of disorders, including breast cancer. For its diagnosis, MRI is employed along with a chemical compound called contrast agent to enhance the visualization of tumoral structures in tissue. This examination is usually called dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI). However, the resolution of the images or the MRI equipment measured in Teslas (T), is a vital parameter for correctly visualizing inside structures, but this feature increases their prices dramatically, making them inaccessible in some situations. As a result, scientific research to improve image quality without spending additional costs or equipment has lately emerged. This work proposes the use of a deep learning strategy to improve the quality of medical images obtained in DCE-MRI. Images from the Qin breast dataset are synthetically degraded by adding noise and applying a spatial transformation (size reduction). The original image is then reconstructed from the degraded ones by using a Convolutional Autoencoder (CAE) to minimize the difference between them. The results of computational similarity metrics such as mean squared error (MSE), peak signal to noise ratio (PSNR), and structural similarity index measure (SSIM) revealed an effective correspondence and visualization between the synthesized and original images at a broad level (full image) and in specific regions of interest (breast tissue).

ID: 52

Squamous cell evaluation in stages 0 and 1 as diagnostic support in cervical cancer

Juan Beltrán, Rubén Castañeda and Miguel Beltrán

Cervical cancer is a pathology that affects a large percentage of the female population in Colombia. This cancer is diagnosed by colposcopy images, nevertheless, this diagnosis is challenging due to factors such as: the dependence on the doctor's expertise, noise in the images, and the inter-intra subject variability. This paper presents an algorithm based on supervised learning and digital image processing, providing diagnostic support to the health professional in the evaluation of stage 0 and 1 squamous cell cervical cancer, using the recognition patterns that allow us identifies the stages of this pathology. The proposed approach is basically the suite of four steps: first, cervix segmentation using a k-means algorithm that is used to find a region of interest. Second, image enhancement to normalize the variability acquisition. Third, feature extraction, and fourth, automatic classification using the SVM technique. The strategy was evaluated using 1000 colposcopy images (70 % for training and 30 % for testing) by Intel & MobileODT , Cervical Cancer Screening Competition Challenge 2017 [1], achieving an 92% of accuracy.

ID: 56



Skin prick test wheal detection in 3D images via convolutional neural networks

Juan Peña, Jose Pacheco and Andrés Marrugo

The skin prick test (SPT) is performed to diagnose different types of allergies. This medical procedure requires measuring the size of the skin wheals that appear when the test is performed. However, the manual measurement method is cumbersome and suffers from intra and inter-observer errors. Thus, multiple approaches have been developed to improve the reproducibility of the test. This work aims to improve part of the automated reading of the SPT to improve the reliability of the wheal detection procedure through the use of convolutional neural networks (CNN). Our proposal starts from the 3D images of the SPT from the arm of patients. They are processed for global surface removal, and then a CNN is trained to produce an output mask that detects the wheals. Finally, the contour of each wheal and its largest diameter is obtained. Encouraging results with mean difference 0.966 mm and mean coefficient of variation 7.29% show that the proposed method provides reliable automated skin wheal detection.

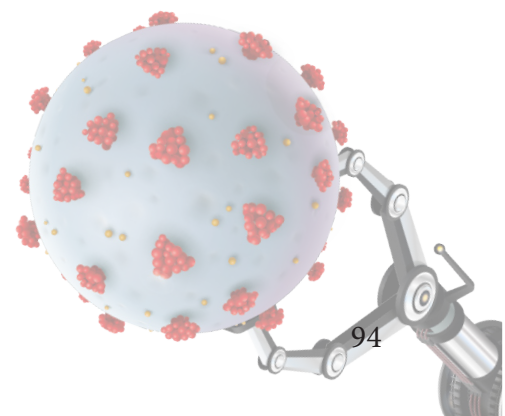
ID: 71

Hirni: Segmentation of Brain Tumors in Multi-parametric Magnetic Resonance Imaging Scans

Gabriel Mejia, Danniell Moreno, Daniela Ruiz and Nicolás Aparicio

Glioma is a type of tumor that develops in the brain and causes cancer in nervous system. They are normally associated with a bad prognosis due to its heterogeneity and the difficulty to resect them. Taking this into account, we developed an algorithm capable of segmenting the brain into four parts: background (brain without tumor), necrotic core (NRC), edematous region (ED) and Active and non-enhancing / necrotic tumor regions (AT). First we approached the problem as a binary case (tumor/non-tumor segmentation) and then we used these masks to improve our multi-class case. For descriptors of each pixel, we used the intensities associated to the four different MRIs contrast media and the prior probability distribution of the training set (two for binary and four for multi-class), and we trained a Random Forest classifier with them. Taking into account the limitation of the computational resources with which we work, our results are outstanding (Dice coefficient 0.806 in the binary case) and competitive with state of the art methods.

ID: 78



Optical Coherency Tomography Analysis for Classification of Retinopathies

Alejandra Erazo-Navas, Isabella Quiroz, Ana S. Ramos-Guerra and Santiago Sánchez-Rentería

“Retinopathies affect over 2200 million people and may lead to severe vision loss and blindness. The classification of retinopathies from Optical Coherence Tomography (OCT) images has been broadly studied given the relevance of its early detection under non-invasive modalities. The following work presents the development of a multiclass classification algorithm based on Histograms of Oriented Gradients (HOG), Local Binary Patterns (LBP) and a Random Forest Classifier (RF) for the detection of Diabetic Macular Edema (DME), Choroidal Neovascularization (CNV), and Drusen. Function parameters for HOG, LBP and RF were optimized iteratively. As a result, the proposed classification algorithm presented a Precision, Recall and F-Score of 0.48, 0.49 and 0.48. Although the combined use of shape and texture descriptors improved the method's performance, several limitations of the algorithm, such as the non-flattening of the retinal curvature in the OCT images, were identified. Future work should focus in overcoming these limitations”

D: 101



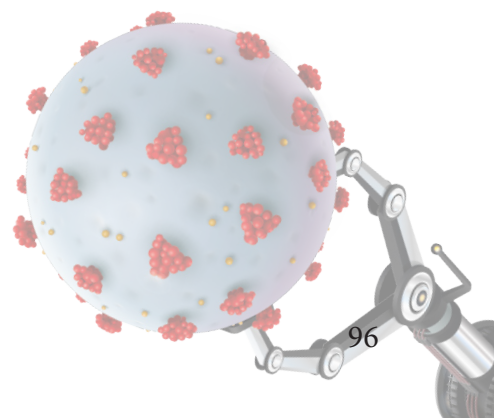
Bayesian Shape Correspondence Analysis of Brain Structures Using Heat Kernel Signatures

Juan Pablo Velasquez Minoli, Hernan Felipe García Arias and Gloria Liliana Porras Hurtado

Neuroimaging problems states a crucial topic due to the need to analyze different tissue properties regarding 3D data. In some neurodegenerative diseases, specific elements within the brain structure begin to lose mass over time. Furthermore, analyzing these brain patterns could be hard to process because of the extensive quantity of information for the specialists. A few changes may be indiscernible to the human eye [1]. Hence, the changes make the clinical diagnosis of a specific neurological disorder challenging. From the computer-vision perspective, the correspondence difficulty consists of analyzing temporal variations of a given neurodegenerative disease across time or finding meaningful relationships between any pair of brain structures [2]. To compute correspondences between complex shapes of 3D meshes is difficult. General matching frameworks need similarity metrics to determine shape relationships challenging to outline and limit the flexibility to model complex shape variations. In addition, these approaches only work for objects of similar size, which ends up in weak performances on non-rigid matching problems [3]. This work proposes a methodology for shape correspondence analysis of non-rigid shapes (i.e., brain structures) for monitoring perinatal asphyxia. Here, we use unsupervised clustering of groupwise 3D descriptors to compute meaningful relations between a pair of brain structures. Moreover, our model allows searching for similar variability

among non-rigid components. Besides, our model can infer the probability of each sample (i.e., a 3D point) and match each vertex around it without any similarity metric. In particular, our investigation has three significant parts. First, our surface descriptors are invariant to curvature, representing the variations between specific regions based on the diffusion heat equation. This method is called Scale-Invariant Heat Kernel Signatures (SI-HKS) [4]. The second one refers to a latent space that permits a more reliable separation of the features. Because the non-rigid shapes present many non-linearities, finding a latent space better separates this matching process. In that way, we propose a Bayesian Gaussian Process Latent Variable Models (BGPLVM) for finding meaningful relations in brain structures in an unsupervised manner [5]. Finally, we use a Gaussian mixture model to infer groups of candidate matches between shapes. The experimental results show how the methodology can efficiently match different parts or regions in 3D shapes while minimizing the geodesic error. We used the Princeton benchmark protocol [6] over the Tosca non-rigid world dataset to evaluate the correspondence quality. Our methodology reached 90% of correspondences with a 0.02955 geodesic error threshold. This result reflects a minimization of error against state-of-art methods such as product manifold filter (0.030) [7], blended intrinsic maps (0.060) [6],

D: 15



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Iris Biometrics Recognition System through Spatial Image Processing

Leanis Julieth Arenas Galvis, Martha Juliana Rey Vanegas, Kevin Daniel Ortega Franco and Manuel Hernando Franco Arias

In this project we aim to develop an Iris Biometrics Recognition System through Spatial Image Processing for each the group members.

Initially, the iris of each member of the group are digitally captured for further processing, in which the images are smoothed and remove the noise of this, subsequently, the region of interest (ROI) is set up and the information out of the ROI is eliminated. The correlation masks are defined based on the information obtained previously; these masks will be the relevant characteristics at the moment of performing the iris recognition of each one of the members. Such recognition will be carried out through spatial cross-correlation technique between the image uploaded to the system and the masks obtained from each of the members, so that the iris recognition will be given according to the highest percentage of correlation obtained.

To obtain the images a 64Mpx smartphone camera was used, obtaining images with a resolution of 1200x1600px, for the illumination a warm light lamp was used which allowed to visualize more easily the anatomical details present in the iris of each member at the time of shooting the photographs, these were taken at approximately 8cm from the eye of each member. Matlab R2020a software was used to image processing, noise removal techniques were implemented through histogram equalization to achieve a smoothed image. Consequently, ROI was manually set up considering that the relevant information for the recognition in question is found only in the iris, from which a differentiating segment is manually selected, whose

resolution is lower than that of the previously identified region of interest, which will be set up as the mask of each member.

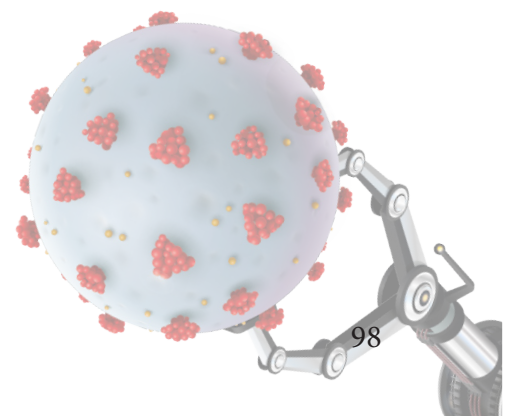
The algorithm performs the identification of an iris image of a member by cross-correlation between this image and each of the previously obtained masks, finally the mask with which the highest correlation index is obtained will be that of the person to which the iris of the loaded image belongs. This algorithm was condensed through a graphical interface using the Matlab software GUIDE, in which the concepts explained previously are represented with greater dynamism.

An application was developed based on an algorithm oriented to biometric recognition through spatial image processing, using the cross-correlation technique. For an effective biometric recognition, it is necessary to identify with a high level of detail the anatomical structures of interest, which in this case were the differentiating and unique factors that each person possesses, also, this improves the accuracy of the results by implementing the cross-correlation technique. Different image smoothing techniques were implemented, where it was identified that the best way to appreciate the details present in the iris was with histogram equalization. The cross-correlation technique does not require a big computational processing power to be executed, which improves the versatility of the application and the algorithm performed. Spatial processing techniques allow the recognition and classification of general features in an object; however, it is proposed to use frequency processing techniques to improve the results obtained. It is proposed that the developed algorithm can be applied in the future in different biometric security systems

ID: 54

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Estimación del volumen tiroideo en imágenes de ultrasonido utilizando redes generativas adversarias condicionadas

Andres Jimenez Garcia, Hernan Felipe Garcia Arias and Gloria Liliana Porras Hurtado

La glándula tiroidea juega un papel fundamental en el desarrollo del metabolismo, por lo que monitorear su comportamiento permite identificar problemas tales como valores anormales en el volumen tiroideo, lo que sugiere cambios en la secreción normal de la hormona tiroidea [1]. El análisis de la tiroides puede ser realizado por medio de imágenes diagnósticas como la tomografía computarizada (CT) o ultrasonido (US), este último presenta ventajas sobre otras metodologías como la disminución en los costos de operación, visualización en tiempo real y representar un bajo riesgo al paciente debido a su naturaleza no invasiva y no ionizante [2]. Sin embargo, a pesar de ser la herramienta inicial para el análisis del volumen tiroideo, se presentan dificultades en el estudio de este tipo de imágenes debido al bajo contraste, ruido multiplicativo acústico, artefactos y variabilidad anatómica en las estructuras tiroideas. Lo cual implica que el análisis deba ser desarrollado por un profesional con experiencia suficiente para identificar correctamente en la imagen la región correspondiente a la glándula tiroidea [1][2][3]. Desde el área de la inteligencia artificial se ha abordado el reto que implica segmentar el volumen tiroideo a través de ultrasonido por medio de modelos basados en aprendizaje profundo, tales como redes neuronales con funciones de base radial (RBF-NN) [1] y redes neuronales convolucionales (CNN) [2][3][4]. Con lo cual, a pesar de que la calidad en los trabajos desarrollados presenta un desempeño que permite identificar el volumen tiroideo, se reportan problemas con relación a la cantidad de datos disponibles para el estudio y la alta heterogeneidad en la variación de la forma de este tipo de estructuras, lo cual hace que estos modelos puedan ser engañados fácilmente. Es por esto, que en este trabajo se propone un nuevo enfoque para estimar el volumen tiroideo a partir de imágenes de ul-

trasonido basado en técnicas de deformación para el aumento de datos y una metodología de entrenamiento adversario con redes generativas adversarias condicionadas (CGAN). El enfoque desarrollado presenta la ventaja de modelar de forma implícita el contorno tiroideo, al entrenar una red generadora de segmentaciones tipo U-net para engañar a una red neuronal discriminadora. Esta segunda red se entrena para clasificar por parches la segmentación evaluada, siendo condicionada por la imagen de ultrasonido asociada a dicha segmentación. La red discriminadora indica las secciones en donde la segmentación puede pertenecer al conjunto de entrenamiento o ser estimada por la red generadora. Además, la actualización de los pesos del generador se realiza mediante la pérdida obtenida por el discriminador al evaluar un dato generado considerando proveniente de la base de datos (error adversario), permitiendo considerar un criterio que cuantifica implícitamente la calidad de las segmentaciones predichas, así como con las funciones de pérdida Dice Loss o el índice de intersección sobre la unión (IoU) en distintos experimentos, estas funciones son empleados para calcular la similitud entre la segmentación estimada y la real. Para el desarrollo del proyecto se utiliza la base de datos UNAL DDTI [5], la cual contiene 134 imágenes de ultrasonido provenientes de 94 pacientes. La metodología propuesta permite segmentar el volumen de la glándula tiroidea considerando la variabilidad anatómica entre las estructuras por medio de un entrenamiento adversario supervisado en el cual se evidencian las ventajas de este tipo de enfoques al disminuir los falsos positivos. Los resultados experimentales durante la etapa de validación muestran que el modelo propuesto estima la región tiroidea con una exactitud del 47.83% empleando como métrica de evaluación el índice de Jaccard.

ID: 3



Medical Image Registration using optimized Affine Transformations with Bayesian Optimization

Mauricio Castaño Aguirre, Hernan Felipe Garcia Arias and Gloria Liliana Porras Hurtado

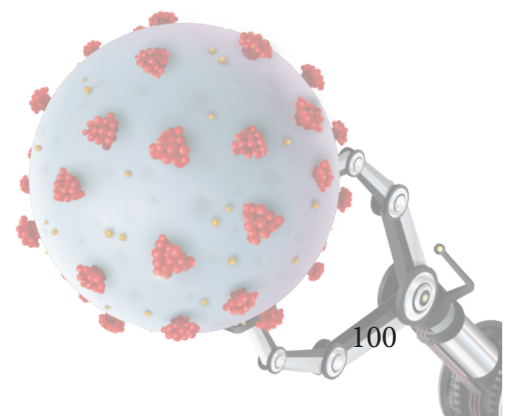
During the last few years, machine learning in medical image analysis has proven to be a strategy that solves many problems that arise from the variability that exists in the physician's outlines and the amount of time that each physician spends [1]. One of the most critical medical image analysis approaches is Medical Image Registration and has been a topic of active research for the last years. Image registration is a crucial step for image analysis. Relevant information is presented in more than one source, i.e., images acquired at different times, from distinct viewpoints, or by different sensors [4][5]. Therefore, the accurate integration of helpful information from two or more views is crucial. Typical registration methods have four main components: The transformation type, which defines the mapping between the two images. The similarity metric reflects the relationship between the images. Then, the optimizer is the iterative method that decides the step followed in the transformation and the interpolation to match the two images. For the input data, we used 3D point cloud data obtained from Medical Images and Tosca dataset [6]. In this paper, we proposed a Bayesian Optimization framework for medical image registration. Here, we rely on a modified version of the Iterative Closest Point (ICP) algorithm [3]. This algorithm built a black box function that receives input parameters for performing an affine transformation. Then, we used a similarity metric that shows the performance of the transformation, like Mutual Information (MI) or Root Mean Square Error (RMS). With this similarity metric, we built a function to define a Bayesian strategy that allows us to find the global optimum of the similarity metric-based function. To this end, we used Bayesian Optimization [2], which Performs global optimization of unknown functions making observations and performing probabilistic calculations. This model considers

all the previous observations, which prevents the strategy from falling into an optimal local, as often happens in strategies based on classical optimization approaches such as Gradient Descent. Finally, we compare the performance of the proposed method with the common registration approaches in the state of art. The experimental results show a faster convergence towards the global optimum and building. Besides, the proposed model evidenced robust optimization results for registration strategies in medical images, showing better exploitation and exploration of the grid search, obtaining and average RMS of 1.9 mm

ID: 23

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Diseño de una interfaz automática para detección y clasificación de la huella plantar a partir de registros fotográficos mediante visión artificial

Natali Olaya Mira and Santiago Mena Suárez

Las presiones plantares son la proyección de la carga corporal sobre las plantas de los pies en posición de bipedestación (estática) o durante el gesto de la marcha (dinámica). La determinación de la huella plantar estática, se basa en el análisis visual de las huellas plantares por medio de una medición cuantitativa. Actualmente existen diferentes protocolos de tipificación, uno de ellos es el protocolo de Hernández-Corvo, el cual tipifica el pie principalmente como cavo, normal o plano dependiendo de las distancias que hay en la zona posterior y media de la planta del pie. El protocolo de Hernández-Corvo se debe realizar mediante la toma y medición de la huella plantar de forma manual, lo cual está sujeta a un margen de error a lo largo de todo el proceso. El objetivo de este estudio es desarrollar un algoritmo que permita aplicar el protocolo Hernández-Corvo de forma automática mediante entornos de desarrollo para la programación de la interfaz gráfica. Para ello se utilizó el algoritmo de suavizado y umbralización de imágenes, se aplicaron transformaciones morfológicas y detección de contornos por medio del método findContours en OpenCV v.4. También, se utilizaron entornos de desarrollo para la programación de la interfaz gráfica con QtCreator v.4 y PyQt5. Luego, se obtuvieron los registros de las huellas plantares de 10 personas para ser escaneados posteriormente y realizar la prueba piloto de funcionamiento de la aplicación. En total fueron 20 huellas plantares a las cuales se les aplicó el algoritmo que permite ejecutar el protocolo de tipificación automático mediante Python v.3.8, de forma que divide la huella plantar en varias secciones y calcula la distancia entre los puntos específicos establecidos en el protocolo. El algoritmo automatizó la tipificación de la huella plantar aplicando el protocolo de Hernán-

dez-Corvo, dando como resultado una rápida clasificación. No obstante, se tiene un margen de error durante el proceso por lo que se debe comprobar el tiempo de tipificación de forma manual y validar con otro protocolo de tipificación como el índice del arco. Además, se requiere incrementar el tamaño muestral de huellas plantares para poder cuantificar mejor el margen de error y perfeccionar el algoritmo.

ID: 80

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Detección de Infección Pulmonar por COVID-19 Mediante Algoritmos de Deep Learning en Imágenes Radiológicas

Karen Tatiana Valencia Rivero, S.L. Begambre, Angie García and Yeison Roncancio

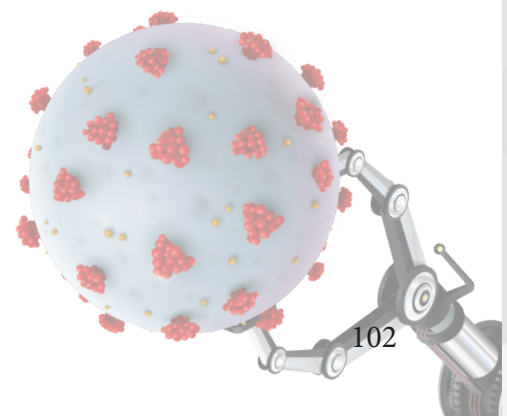
El acelerado desarrollo que han experimentado las ciencias de la computación de la mano de la ingeniería biomédica en las últimas décadas motiva el uso de diferentes tecnologías de la información y la computación para asistir a los profesionales de la salud en el diagnóstico y tratamiento de enfermedades [1]. El objetivo del presente proyecto es diseñar, implementar y validar un algoritmo para la identificación cuantificada de infección pulmonar por COVID-19 mediante imágenes médicas empleando técnicas de Machine Learning, que son herramientas informáticas de enorme potencial en el desarrollo de aplicaciones y algoritmos para el diagnóstico asistido por computador. Para el desarrollo de este proyecto, se realizó una colaboración entre la Universidad Manuela Beltrán y la Clínica Nueva, entidad médica que brindó una base de datos con imágenes médicas (rayos X), de pacientes que presenten infección pulmonar por COVID-19 reportados ante las entidades de control epidemiológico de la ciudad como positivos para infección por SARS CoV2. La extracción de las imágenes médicas se tomó de 2441 pacientes, en total se cuenta con 5.486 imágenes, 2743 verticales y 2743 laterales. Esta base de datos obtenida en esta investigación quedará de libre acceso para futuras investigaciones. Para la generación de los resultados y la validación del algoritmo que pueda predecir mediante una imagen radiológica la aparición de Sars-Cov2, se desarrollaron Redes Neuronales Convolucionales procesando las imágenes por grupos arrojando un porcentaje de exactitud de casi el 92%. Es importante establecer que además de utilizar imágenes con paciente COVID-19 y pacientes sanos, el algoritmo también compara y procesa pacientes con imágenes de Neumonía y Asma, esto con el fin de evitar falsos positivos

en el diagnóstico asistido que entrega el algoritmo al profesional de la salud. Actualmente se están realizando las últimas pruebas en campo para tener aprobación del Departamento de Radiología de la Clínica Nueva y proceder a la implementación de esta herramienta como una opción costo-efectiva para la detección temprana de esta enfermedad en esta y otras instituciones prestadoras de salud.

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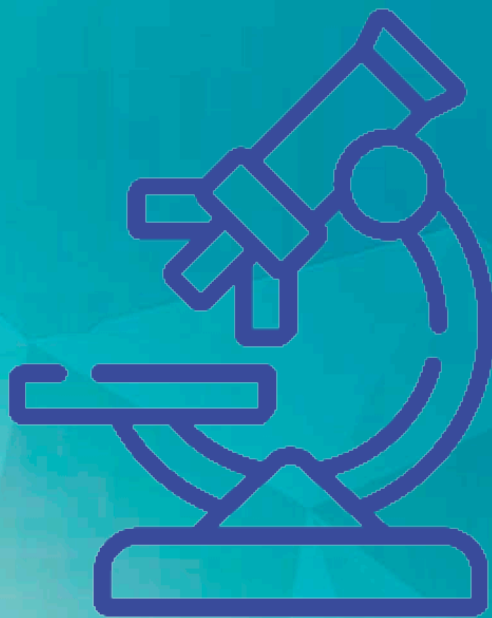
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2^{do} CONGRESO INTERNACIONAL
DE INGENIERÍA BIOMÉDICA Y
BIOINGENIERÍA (CI-IB&BI 2021)

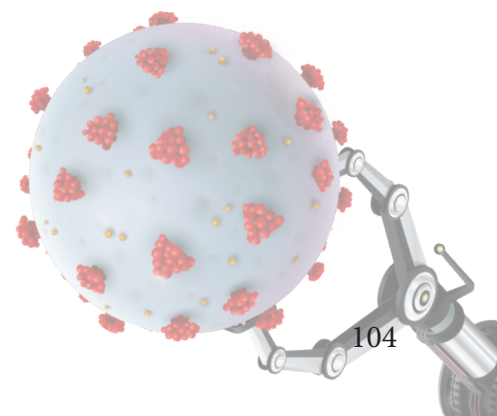


Ingeniería de Tejidos

Preparation and characterization of chitosan/gelatin /PVA scaffolds for tissue engineering application

Yesenia Sánchez Cardona, Martha Elena Londoño López, Claudia Elena Echeverri Cuartas and Natalia Rocío Moreno Castellanos

In recent decades the use of polymeric scaffolds for growing cells has been a large increase because of its promising applications in tissue engineering (TE). The objective of this study is to propose an alternative of chitosan (Chi), gelatin (Ge) and polyvinyl alcohol (PVA) scaffold, for growing cells, prepared at different Chi/Ge/PVA weight ratios of 1:1:1, 2:2:1, 2:3:1 and 3:2:1 these scaffolds were obtained through freeze-thaw cycles followed by lyophilization. The scaffolds, characteristics such as: morphology, pore size, porosity, swelling, degradation, mechanical properties, functional groups, and cell viability were evaluated. Scaffolds with pores over the entire surface, with heterogeneous pore sizes that varied between 0.6-265 μm , an interconnected three-dimensional network scaffold with porosity greater than 80% were obtained. The highest compressive strength reached 101.6 Pa. The scaffolds had a maximum swelling capacity greater than 600% and a controllable degradation rate, conserving their three-dimensional network structure after 28 days of being immersed in PBS. Additionally, scaffolds Chi/Ge/ PVA 2:3:1 and 3:2:1 was the highest cell viability presented. From the results obtained, it can be concluded that the technique used to manufacture the scaffolds was simple, which increases their reproducibility. It was observed that this technique positively influenced pore formation and size in scaffolds. All these characteristics generate an important effect on the diffusion of nutrients, adhesion, and cell viability. Finally, the high porosity of the scaffolds influenced the mechanical properties, and these properties are fundamental because the scaffolds must have the ability to resist loads and transfer it correctly to the cells. Additionally, these mechanical properties allow the scaffolds to be easily manipulated at the time of being implemented in the crop and these could maintain rigidity while allowing the formation of extracellular matrix (ECM). These results suggest that Chi/Ge/PVA scaffolds are a promising alternative to improve the viability of BRIN-BD11 cells in vitro.



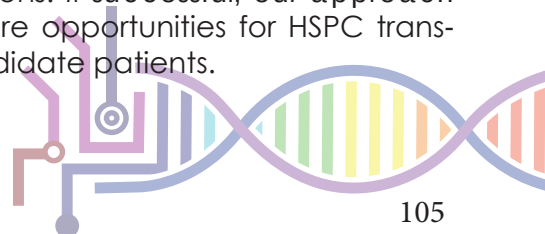
Standardization of a 3D bioprinting platform for hematopoietic progenitor cells proliferation: conditions for a small intestinal submucosa based bioink

Laura Liliana Delgado-Murillo, Bellaneth Devia, Ana María Perdomo-Arciniegas, Juan Carlos Cruz and Carolina Muñoz-Carmargo

Hematopoietic stem cells and progenitor cells (HSPC) transplantation is a current therapy for both malignant or non-malignant diseases. Despite the considerable increase in transplants using this therapy, there is a major limitation regarding the number of cells available to cover the current increasing demand [1, 2]. Recently, HSPC transplantation from different sources (e.g., mobilized peripheral blood and umbilical cord blood (UCB)) emerged as an alternative therapy to bone marrow aspiration, a highly invasive procedure [3]. These cells are characterized for having abilities of self-renewal and differentiation toward different blood cellular lineages. These processes are tightly regulated by signals coming from stromal and/or vascular cells found in the bone marrow microenvironment, in which, among other factors, the hypoxia plays a central role in cellular proliferation and differentiation. Nowadays, it is known that HSPC isolated from UCB exhibit a more primitive character than their counterparts, and consequently, a greater proliferative capacity. However, in comparison with other HSPC sources, UCB cells have approximately ten times less nucleated cells and therefore, less minimum cell dosage available per unit [4, 5]. This shortcoming can be solved by expanding HSPC derived from UCB, which is believed to assure high availability of cells to achieve better transplantation outcomes. This project aims to evaluate the proliferation of hematopoietic progenitor cells when cultured in vitro in an environment that mimics their physiological niche. This is critical to ensure that more patients can access readily available transplants on demand. The HSPC will be embedded in a hydrogel based on a decellularized extracellular matrix derived

from porcine intestinal submucosa chemically modified with methacrylic acid (SISMA) for extrusion in a construct obtained via 3D bioprinting. SISMA shares numerous molecules with the hematopoietic microenvironment, which is mainly composed of type I collagen [6], proteins such as elastin, laminin and fibronectin [7, 8, 9], as well as proteoglycans and glycosaminoglycans, also found in bone marrow [6, 10]. To standardize the 3D bioprinting conditions for HSPC using the developed bioink, we first used several leukemic cell lines with different lineage of commitment (i.e., Jurkat, U937, K562 and Nalm6). Accordingly, we developed a robust counting method, growth curves and response to hypoxia in suspension culture conditions, which allowed us to select the most proliferative cell line compared with hydrogel embedded culture conditions. As a result, Jurkat and U937 cell lines were found to be the most proliferative, followed by Nalm6, and K562 cell lines. Additionally, when compared with a hypoxic culture setting (5%O₂), we found that overall under normoxia (21%O₂), proliferation of the majority of leukemic cell lines decreased significantly. Once the synthesis of the SISMA bioink was finished, the Jurkat cells were embedded in it followed by the 3D bioprinting process. Cell viability of the obtained constructs was evaluated at days 1 and 6 post extrusion via live and dead staining, using confocal imaging, as well as via alamar blue. The number of cells within the construct tripled from day 1 to day 6 but quadrupled in suspension culture conditions. This suggests that there is still room for improvement by the engineering of the hydrogel, which most likely includes changes in its mechanical response such that the cell niche is mimicked more accurately. This should be accompanied by optimization and subsequent standardization of growth conditions, which is a bottom-up process that involves estimating the relative impact of the relevant parameters on the viability of the 3D bioprinted constructs. Some of these parameters include the presence and absence of growth factors (Stem Cell Factor, Thrombopoietin and Flt3-ligand) and changes in the O₂ concentrations. If successful, our approach will provide more opportunities for HSPC transplantation candidate patients.

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Simulación del método de liofilización de un cultivo celular epidérmico

Oscar Santiago Garzón Banoy, Angélica Ramirez-Martínez and Élica Hermida

El crecimiento tridimensional de las células requiere de un andamio (scaffold), que consiste principalmente en una matriz polimérica, que sirve de plataforma de anclaje para la adhesión de células y permitir así su crecimiento [1]. Para la generación de andamios para cultivo de tejidos anisótropos, se utiliza principalmente el método de liofilización. En este proceso se elimina el solvente del polímero así como el agua dentro de él, para generar los poros dentro del andamio, a través de una secuencia de etapas de congelamiento y secado, dentro de una cámara de vacío [2]. Las presiones y temperaturas con las que se regula el proceso de liofilización, afecta la porosidad final del andamio. Se ha encontrado, que estos parámetros aún son definidos en laboratorio por ensayo y error. Por tal motivo, el objetivo de este estudio es simular la etapa de secado del agua en la matriz y de esta forma identificar la densidad de tamaño de poro generado, de acuerdo a un rango de presiones y temperaturas definidas. Se realizan una serie de simulaciones de CFD (Computational Fluid Dynamic) en ANSYS Workbench® [3] variando la temperatura de sublimación entre 0 a 22 °C para medir la densidad de las poros luego de la liofilización. Para esto, se utiliza una geometría proveniente de un andamio nanocompuesto[4], como se observa en la figura 1a-b, simplificado a una sección cuadrada de 10x10 mm con una matriz de polímero PHBV (polihidroxicanoato) reticulado de 3x3 [5]. Dentro de cada retícula se aloja agua congelada que será secada en el proceso de liofilización. Se realiza un mallado mixto (triángulos y cuadriláteros) con tamaños máximos de 0.2 mm para un total de 7130 elementos. Como condiciones de contorno se interpone convección alrededor de las paredes del polímero con un $h=5 \text{ w/m}^2\text{K}$ correspondiente al coeficiente de convección del aire. La parte inferior del soporte tiene contacto con

una placa de aluminio con un coeficiente de conducción de $K=205.W/mK$. El sistema está dentro de una cámara de vacío con unas presiones de 0.01 torr. En los primeros instantes de la simulación se observa el gradiente de temperatura (figura 1.c) desde el color rojo con valores de 22 °C, correspondiente a la temperatura ambiente a la que se encuentra la cámara de vacío, hasta el color azul (0 °C) propio del congelamiento dentro del andamio, tanto del agua como del PHBV. En la figura 1d, se observa la fracción parcial de líquido, es decir la cantidad de hielo convertido en agua, mostrando una fusión del hielo en un gradiente del exterior hacia el centro de la geometría. Esto nos da un aproximado del 89% de la conformación de los poros, que sucederán cerca de la superficie y menos al interior del andamio.

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Towards the use of the 3D bioprinting technology as a new alternative to generate alveolar bone: Addressing orofacial clefts

Santiago Alzate Urrea, Maria Alejandra. Rodríguez Soto, Juan C. Jiménez and Carolina Muñoz Camargo

Alveolar bone surrounds the teeth and is in constant remodeling to grow and to adapt to maxillars changing shape and size to teeth. and it is of great interest due to its involvement in different oral conditions such as periodontal disease, periapical infections, craniofacial traumas, and congenital orofacial clefts [1]–[3]. Clef lip and/or palate (CL/P) is characterized by the formation of gaps or openings in the upper lip and palate, leading to difficulties in different processes such as chewing, breathing, swallowing and phonation, in addition to negatively impacting self-perception[2]–[4]. To address the requirements of alveolar bone grafts, different strategies have been developed, including bone autologous grafts, bone fillers with different kind of biomaterials, and cell therapies based in cell progenitors and stem cells [1]–[3], [5]–[8]. However, to our knowledge there is no definitive solution available for patients with CL/P, even after several surgical interventions that are costly, painful and can have a detrimental impact on the life quality for those suffering from this condition[8], [9]. This situation has led to an increasing interest in the use of bio-ceramic scaffolds with hydroxyapatite (HA) and demineralized bone matrix that is then seeded with stem cells that under proper stimuli can be differentiated towards osteogenic phenotypes (Osteoblast) for bone regeneration. There are three main types of adult stem cells[10]–[13], the most known and studied are hematopoietic stem cells (which can be derived from bone marrow, umbilical cord and placenta), mesenchymal adipose stem cells, and more recently, dental pulp mesenchymal stem cells. For their easy availability and differentiation potential the best alveolar regeneration to address CL/P are dental pulp mesenchymal stem cells, which

can be typically found in third molars and temporal teeth [14]–[17]. There are three major challenges associated with alveolar bone generation: to achieve osteointegration, osteoconduction and osteoinduction during the growth of new bone [18]–[20]. In this regard, we have performed a literature review for the current strategies in alveolar bone regeneration. We have found that the development of extrusion-based 3D bioprinting technology, an advanced biofabrication technique with the potential to displace conventional scaffold-based strategies, can provide a promising platform to create sophisticated 3D constructs, according to the bone defect, by extruding hydrogels with embedded cells (also known as bioinks) [21]–[23]. Compared to traditional scaffolds, this technology offers the possibility of more controlled cell organization within the matrix manipulating specific parameters that will allow it to mimic the native tissue [24]–[27]. Thus far, various studies have put forward biomaterials and 3D printing scaffold-based approaches, e.g., Ahn, G, et al. [28] used bone marrow derived mesenchymal stem cells seeded on a 3D printed patient specific polycaprolactone scaffolds for alveolar cleft reconstruction in young children. After six months, the authors reported 45% of bone regeneration with respect to the total initial defect volume. However, the scaffold fails to demonstrate bioactive properties and mechanical stimulation to lead to proper vascularizations [28] [29]. In addition to this particular approach Rizzo, et al. [28] use decellularized porcine palate tissue (mucoperiostium) to fabricate an scaffold seeded with MSC from BN cells for potential CL/P repair due to the the natural bioactive properties and to the similarity with native palate human tissue. Despite this promising approach to alleviate CL/P consequences, there are no preclinical or clinical trials that demonstrated safety and efficacy. . Currently with the advent of new technologies such as 3D bioprinting and with the fundamental understanding of the mechanisms for bone regeneration, it could be possible to explore new strategies and achieve a site-specific arrangement of alveolar bone cell types precursors. This might be also combined with the fine tuning of bioprinted constructs with customized geometries [30] that fulfill the three major challenges (osseointegration, osteoconduction and osteoinduction) to generate alveolar bone. Although some studies have reported

bioprinting with hydrogels or molecules derived from extracellular matrices (ECMs) of different tissues [31]. , Until now there is no study reporting the use of ECM bionks combined with dental pulp stem cells to generate e alveolar bone constructs via 3D bioprinting. Accordingly, we believe that natural and conserved components of ECMs can promote differentiation, proliferation, and maturation of dental pulp stem cells into alveolar bone. This will potentially allow to develop a more effective and less invasive solution to CL/P patients.derived from extracellular matrices (ECMs) of different tissues [31]. , Until now there is no study reporting the use of ECM bionks combined with dental pulp stem cells to generate e alveolar bone constructs via 3D bioprinting. Accordingly, we believe that natural and conserved components of ECMs can promote differentiation, proliferation, and maturation of dental pulp stem cells into alveolar bone. This will potentially allow to develop a more effective and less invasive solution to CL/P patients.

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Evaluación del efecto genoprotector de un extracto de agraz en un modelo celular in vitro de células de piel expuestas a estrés oxidativo

Daniela A. Maya-Cano and Gloria A. Santa-González

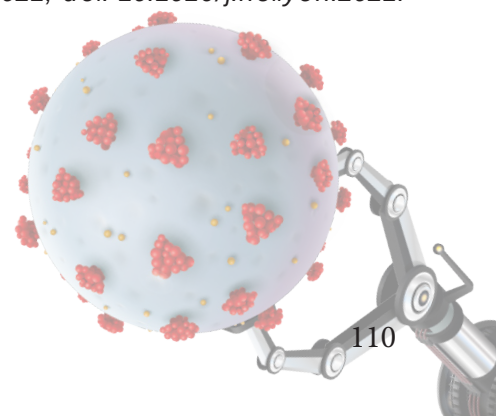
El aumento de las afecciones cutáneas y principalmente del cáncer de piel ha convertido esta enfermedad en un problema de salud pública debido al elevado número de casos y de muertes en todo el mundo [1]. Uno de los principales factores de riesgo para desarrollar la enfermedad es la incidencia de la radiación ultravioleta en la piel, con la que pueden generarse especies reactivas de oxígeno (ROS) y provocar reacciones mutagénicas y cancerígenas [2], [3]. En los últimos años, el uso de productos y compuestos naturales obtenidos a partir de plantas ha tenido gran acogida en la investigación biomédica como una alternativa para la prevención y el tratamiento de diferentes enfermedades y problemas en la salud humana, esto debido a las propiedades farmacológicas con las que cuentan. Entre estos productos naturales, las bayas de agraz (*Vaccinium meridionale* Swartz) han mostrado un potencial efecto antioxidante y genoprotector debido a los compuestos polifenólicos presentes en este fruto [4], [5]. En este estudio se evaluó un extracto de bayas de agraz para determinar su efecto como una alternativa protectora frente al daño cutáneo inducido por ROS. Para ello, se preparó el extracto crudo empleando bayas de agraz obtenidas comercialmente; el proceso de extracción se realizó por sonicación empleando diferentes frecuencias y mezcla de solvente agua:etanol. Se emplearon como modelo las células Ha-CaT, derivadas de queratinocitos humanos no malignos, cultivadas en DMEM al 5% de SBF y mantenidas en ambiente húmedo a 37°C y 5% de CO₂. Para los tratamientos, se sembraron 5 x 10⁵ células/pozo en microplatos de 6 pozos, y tras permitir su adhesión, las células fueron expuestas por 24 horas a concentraciones del extracto entre 0,25 y 10,0 mg/ml; durante la úl-

tima hora de exposición al extracto, se adicionó como cotratamiento el agente pro-oxidante peróxido de hidrógeno a concentraciones de 0,5 y 1,0 mM. Para determinar la actividad biológica se llevaron a cabo mediciones de viabilidad celular y cuantificación de ROS intracelulares empleando citometría de flujo, y cuantificación de daño en el DNA empleando el ensayo DNA cometa. Los resultados preliminares muestran una modulación de los niveles de ROS y disminución del daño en el DNA, lo que es indicativo de las propiedades antioxidantes y genoprotectoras del agraz frente al daño inducido por estrés oxidativo en células de piel. Estos datos sugieren un posible efecto quimiopreventivo del extracto de agraz en las células de piel; se requieren estudios adicionales para investigar su mecanismo de acción.

ID: 79

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Classification of Failure Causes of Tissue Engineered Vascular grafts

Natalia A. Suárez V., Maria A Rodriguez Soto, R. Alejandra Riveros C, Juan C. Cruz, Carolina Muñoz C. and Juan C Briceño T

Tissue Engineered Vascular Grafts (TEVGs) represent a promising alternative for vascular diseases that need the replacement of damaged vessels (or to create non physiological connections) for operation under complex hemodynamic conditions [1]. Under such circumstances, synthetic grafts are incapable of sustaining long-term patency because of their limited ability to integrate with the native tissue. As a result, they develop altered compensation mechanisms to regulate the inflammatory response, the coagulation cascade and ultimately control the blood flow [1][2]. These changes generally result in occlusion of the graft or in undesirable physical alterations of the graft material, which, in turn, impairs proper oxygen perfusion towards the tissue of interest. For this reason, TEVGs are expected to promote integration with the adjacent vessels and consequently promote vascular wall remodeling to favor uninterrupted blood flow and therefore allow physiological mechanisms to modulate vessel response to complex hemodynamic conditions. However, despite several attempts to improve the performance through different tissue engineering strategies, most published TEVGs still report failure events throughout the integration process when tested preclinically. As a result, their use at the clinical level has been significantly limited.

We hypothesized that the grafts fail because of an inadequate response of blood cells and the vascular wall when in contact with graft biomaterials under the hemodynamic conditions of the implantation site. We studied the failure of several TEVGs in preclinical testing and were able to identify and classify the reason why grafts fail to complete regeneration during the length of the test [3]. We defined three phases within the integration process. Phase I: Peri implantation period, in which grafts fail due to acute responses of the inflammatory system to the graft biomaterial or because of surgical com-

plications. Phase II: In which grafts fail because of the presence of chronic inflammatory response and the reendothelialization process of the inner surface of the graft is either inexistent or fails to show the typical biological features to become a functional mature endothelium [4]. And Phase III: That comprises the period in which the graft is under operation after having successfully stabilized hemodynamics and immune response. Importantly, TEVGs' failure in Phase III by long-term loss of patency is mainly related to their inability to sustain an adequate remodeling process of the vascular wall and behave as non-regenerative devices, and not necessarily to their performance as blood conduits or the presence of strong immune response [1].

We discovered that one of the main reasons why it is difficult to analyze these results and translate TEVGs to the clinical practice, is the lack of standardized parameters to determine the TEVGs' failure and led to compared with the performance of others TEVGs'. For example, numerous studies define non-successful grafts by considering different percentages of patency loss or different percentages of inner surface coverage by pro-endothelial. Furthermore, we noticed that these types of failure occur in every type of analyzed animal model, independently of the species and also they occur for both biologically originated grafts as well as synthetic ones. We hope that this classification mechanisms and grouped causes of failure can be useful to proposals of rational design of TEVGs and their translation to the clinical practice.

ID: 95



Amniotic membrane-derived extracellular matrix-based hydrogels for the improved maturation of human retinal pigment epithelium in vitro models

Julian A Serna, Javier Cifuentes, Laura Rueda, Luis A Ruiz, Bernardo Quijano, Paula X Pavía, Camila A Camargo, Juan C Cruz, and Carolina Muñoz-Camargo

The retinal pigment epithelium (RPE) is a cell monolayer present in the human retina. Its most relevant role is providing support for the correct function of the neural retina by facilitating water and molecule transport between the choroid and the retina, producing and secreting growth factors, and phagocytosing photoreceptor outer segments [1, 2]. The RPE rests on top of the Bruch's membrane, which is a thin layer of extracellular matrix that separates the choroid from the retina. In combination, RPE and the Bruch's membrane act as a permeable barrier for controlling waste and nutrient transport between the photoreceptors and the choroid [1]. Impairment of the RPE, and thus of the photoreceptors that rely on its correct function, is often seen in vision loss-related diseases such as age-related macular degeneration, retinitis pigmentosa and Stargardt disease [3, 4]. Despite these being among the leading causes of vision loss in the elderly population worldwide, current treatments are focused on stopping disease progression instead of repairing the damaged tissues. As an alternative to conventional clinical management, recent studies have proposed the use of biofabrication technologies for creating transplantable models of human RPE [5]. Here we propose the use of porcine amniotic membrane-derived extracellular matrix (ECM)-based hydrogels for fabricating in vitro RPE models. Since hydrogels made of solely tissue-derived ECMs have failed to provide appropriate mechanical properties for tissue engineering [6], a methacryloyl modification was performed and lithium phenyl-2,4,6-trimethylbenzoylphosphinate (LAP) was used as photoinitiator to yield photocrosslinkable hydrogels. Successful methacryloyl modification was con-

firmed by nuclear magnetic resonance (NMR) spectroscopy. The biochemical composition of the modified hydrogels was characterized by means of total protein content, sulfated glycosaminoglycans content and growth factor composition. Printability of the hydrogel was assessed by manual extrusion experiments and via rheology with flow sweep and post-printing recovery tests [7]. For biofabrication experiments, a novel concave and porous microplate insert was 3D printed with PLA and used as a support for the model, which consisted of a thin ECM hydrogel layer with RPE primary cells laying on top. After 7 and 14 days in culture, the integrity and differentiation level of the RPE models was assessed via immunofluorescence, histology and transepithelial electric resistance (TEER). Results showed a higher expression of the junction-specific protein ZO-1 and a higher TEER after 14 days of culture, when compared to models cultured for 7 days. Moreover, hematoxylin and eosin staining showed a highly organized epithelial layer with a clear separation from the ECM region. The preliminary results herein shown demonstrate the potential of these 3D constructs in replicating native tissue structures which could be employed for treating disease in a personalized manner.

ID: 111

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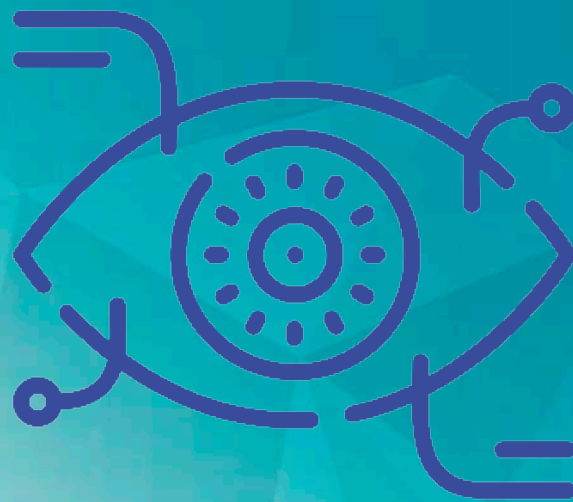
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Inteligencia Artificial

SENMAP: A Convolutional Neural Network Architecture for Curation of LTR-RT Libraries from Plant Genomes

Simón Orozco-Arias, Mariana S. Candal-Cortés, Estiven Valencia-Castrillon, Paula A. Jaimes-Buitrón, Nicolas Tobón, Maradey Arias-Mendoza, Reinel Tabares-Soto, Romain Guyot and Gustavo Isaza

"Transposable elements (TEs) are specific structures of the genome of species, which can move from one location to another. For that reason, they can cause mutations or changes that can be negative, such as the appearance of diseases, or beneficial, such as participating in fundamental roles in the evolution of genomes and genetic diversity. Long Terminal Repeat retrotransposons (LTR-RT) are the most abundant in plant species, hence the importance of studying these structures in particular. Over the time, these elements can suffer changes called nested insertions, which can inactivate or modify the functioning of the element, for that they are no longer consider as intact element and ca not be used for identification and classification studies. In this work we present SENMAP, a convolutional neural network architecture to obtain intact LTR-RT sequences in plant genomes, which is composed by four convolutional layers, LeakyReLU as activation function and BinaryFocalLoss as loss function. Achieving an F1-score percentage of 91.37% with test data, identifying low quality sequences rapidly and efficiently, contributing to curate libraries of LTR retrotransposons of plants genomes published in large-scale sequencing projects due to the post-genomic era"

ID: 104

Real time face mask detection with SSD in the era of Covid-19 pandemic

Erick Lozano Roa, Juan Sebastián Urrea López and Isai Daniel Humberto Chacón Silva

"This paper proposes the Neural Network SSD architecture for the task of face mask detection. We trained this model to detect 3 different categories of people: those wearing a mask, those wearing it incorrectly and those not wearing it. For this proposal, a dataset with 853 images was used with annotations of these 3 classes. For the Neural Network, the weights were initialized from a pretrained model on the image dataset Pascal VOC and fine-tuned to finally achieve a mAP of 70.2% on the validation set. The mAP achieved on the test set was 66.7% which shows that despite the lack of a huge dataset, the architecture SSD is suitable for this task. Additionally, our experiments showed that the MultiBox Loss Function parameters can be modified to improve the performance on small and unbalanced datasets such as the one presented. Current work has focused on the task of classification or detection for a single class. Our work is a novel approach as it performs real-time detection and classification in 3 classes, making it suitable for natural scenarios such as public spaces. Index Terms—Covid-19, Face Mask Detection, Single Shot Detector, MultiBox Loss"

ID: 102



CNN for Breast Cancer Metastases Classification

Nicolas Aparicio, Daniel Chacón and Daniela Ruiz

We present a Deep Convolutional Neural Network based on VGG16 for the classification of patch images from the benchmark of PatchCamelyon 2016. This dataset consists of 327680 color images from histopathologic scans of lymph node sections. The images were originally acquired at 2 different hospital centers with a 40x objective. The main way to optimize the construction of our model was using a train, validation and test set, which is the standard approach to do it. We made changes to the architecture and its parameters one by one, observing its performance in the validation set in terms of accuracy and average loss. Finally, we could obtain a optimized CNN architecture that performed better than the VGG16 model by itself. Also, the AUC's obtained in the valid and test set were 0.91 and 0.90 respectively, which shows the neural network was trained in a optimal way so that it did not perform overfitting. The final accuracy for valid was 89% and 86% for test set. This shows that our model is between those in the state of the art in classification and can be used for further harder problems such as semantic segmentation in the actual Camelyon dataset.

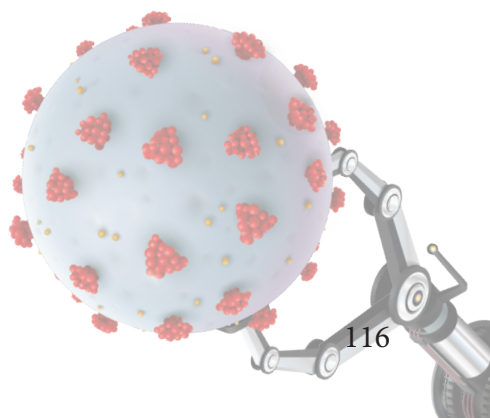
ID: 113

Machine Learning Techniques to Determine Mutation Impact in Proteins Associated to Neurofibromatosis

Haider Rodríguez Pinto, Tatiana Tellez Silva and Alvaro David Orjuela-Cañón

Nowadays, computational intelligence has been employed to predict aspects related to diseases, which has become an essential practice in health around the world. Specifically, this work used the application of support vector machines, artificial neural networks, and random forest models extracted from machine learning approaches. Information from the protein composition based on amino acids was employed to train the models and determine the mutation impact for genetic diseases as neurofibromatosis one and two. A cross-validation method was implemented to analyze the generalization of the mentioned models. Results show that artificial neural networks hold the best performance to determine if the mutation can impact the protein structure. Finally, the aim of this study is to contribute to the understanding of the mutation effect in biomolecules based on computational models based on information extracted from protein sequence data.

ID: 120



Classification of discharge diagnosis in pregnancy electronic health records using natural language processing and supervised learning

Maria Camila Durango Barrera, Andrés Felipe Orozco Duque and Ever Augusto Torres Silva

The Electronic Health Record (EHR) has the capabilities of a clinical decision support system (CDSS). However, the high volume of data and the unstructured information in free text limit the potential that EHR data offers to improve clinical decision-making [1]. The implementation of Natural language processing (NLP) and text mining methods could help to do a better follow-up of patients and support in the identification of risk. Although, the research in NLP applied to EHR is raising, there is a gap in this issue in languages different from English [2]. Particularly, there are not reports in the field of gynecology and obstetrics. We propose a classification scheme, based on the text extracted from the EHR, which can speed up the monitoring of the pregnancy, extract and summarize useful information that serves to support the taking of clinical decisions associated with maternal risk. We used data from the electronic health records (EHR) of pregnant women with deliveries of the obstetrics and gynecology services of the Clínica Universitaria Bolivariana. We identify the EHRs of patients who had deliveries in the institution between 2015 and 2019. We implemented an Extraction, Transformation, and Data Loading (ETL) pipeline to load in a scheme data from the following notes and discharge diagnosis. The unstructured text was pre-processed using tokenizing, removing stop words, normalizing, and removing punctuation [3]. We implemented text mining methods to characterize the EHR and find the most common words and n-grams. We implement a word count function and the frequency of the 100 most common words was used as the input to a logistic regression classifier. We collected 187449 Notes of clinic evolution from EHRs corresponding to 23337 patients and 49383 episodes. On the other hand, we co-

llected 92426 discharge registers. We group the notes per episode and union with the episodes of discharge and filter the dataset per top ten discharge diagnoses frequency. A total of 24005 episodes with discharge diagnosis were obtained. We found that the most common words in the corpus were "no" (not), "signos" (signs), "dolor" (pain). Note that the negation is commonly used in EHR. Additionally, the most common bi-grams were: "signos-alarma" (warning signs), "embarazo-semanas" (pregnancy weeks), "actividaduterina" (uterine activity), "resultados-observaciones" (results - observations) and "sangrado-vaginal" (vaginal bleeding). We develop a 10-classes classification scheme using logistic regression that achieves an accuracy of 0.81 which is comparable with other results using EHR [4]. To our knowledge, there are no other studies that report the use of NLP methods in obstetric and gynecological medical records in Spanish. Our results are a contribution for future studies that will allow in the future an automatic analysis of the EHR for the generation of early warnings concerning maternal risk and thus seek to help reduce the indicators of maternal mortality.

ID: 86

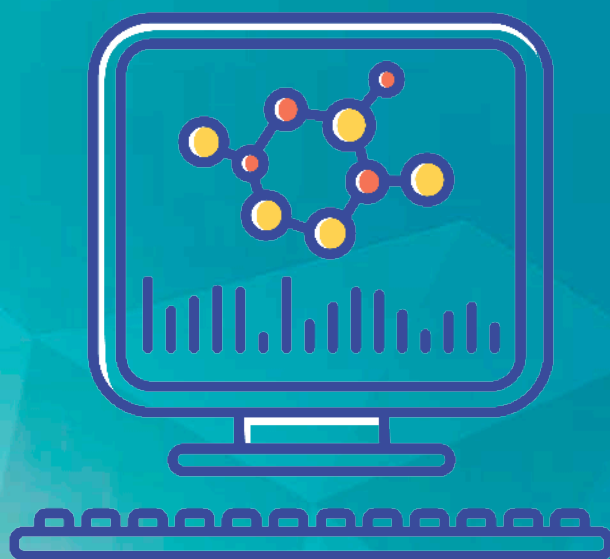
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Modelado y Simulación

Pinched Flow Fractionation for Size-based Separation of Polydisperse Polymeric Microparticles via Low-Cost Microfluidic Device

Saul Camilo Gomez, Valentina Quezada, Isabella Quiroz, Johann F. Osma, Luis Humberto Reyes Barrios and Juan C. Cruz

Microfluidic systems can be simple and efficient devices for different applications in a wide variety of fields. Purification of specific cells, bacterium, or environmental particles are some examples of biomedical, biochemical, and industrial applications. This study aims to achieve an *in silico* and *in vitro* analysis of sedimentation pinched flow fractionation lowcost microfluidic system for size-based separation. To overcome the lack of polydispersity control in the preparation of polymeric microparticles as small-sized particles have greater advantages when it refers to drug-delivery and cell-mimicking. First, a Multiphysics simulation was carried out employing an Eulerian-Lagrangian approach for the prediction of particle sorting in the system. In this, a Flow Rate Ratio of 1:25, 3:100, and 1:50 and a Total Flow Rate of 0.0075 m/s were used. Then, chitosan microparticles between 1-20 μm were synthesized by the single emulsion method to experimentally evaluate the results obtained in the simulations. *In silico* results showed that the microparticles were correctly isolated, with a difference in the size of approximately 5 μm between each outlet channel, there was no significant difference between the Flow Rate Ratios evaluated.

ID: 70

Intensive Care Unit Occupancy Time Series Forecasting for COVID-19 Pandemic

Alvaro David Orjuela-Cañón, Oscar Perdomo, Leonardo Mendoza and Cesar Hernandez Valencia Niño

Nowadays, the pandemic situation because Covid19 affected everything related to the public health infrastructure. One of the most important aspects to treat the Coronavirus contingency was the hospitalization of patients with severe cases, where some cities had high demand of beds in the intensive care units for attending these people. From the engineering tools, time series forecasting has been an alternative for analyzing data in this context. This work proposes to do a forecasting on the demanded beds for the severe cases of Covid-19, employing models from the artificial intelligence. Techniques as fuzzy and neural networks were tried to determine the necessary number of beds through the use of the registration of this information daily, in a Latin American city. Results show that strategies based on neural networks were better compared to fuzzy models, according to the root mean square error. The obtained models can contribute to the authorities in making decision process to react before the similar contingencies.

ID: 121



Modelo de recombinación genética en malaria con dinámicas de transmisión y sus efectos en la clonalidad parasitaria

David S. Salazar, Mauricio Santos-Vega and Juan Manuel Cordovez-Alvarez

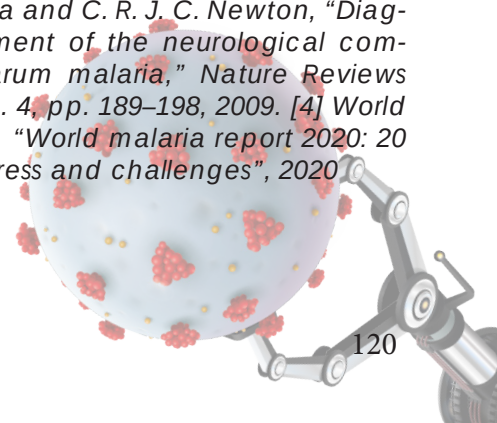
La malaria es una enfermedad causada por protistas unicelulares del género *Plasmodium*, un grupo que incluye parásitos que infectan aves, reptiles, roedores y humanos [1,2]. La malaria puede manifestarse levemente por medio de síntomas como fiebre, escalofríos y en algunos casos puede ser asintomática. Sin embargo, los casos de malaria severa se caracterizan por presentar fiebre, pérdida o alteraciones de la conciencia, anemia severa, dificultad respiratoria, convulsiones e hipoglucemia. Este tipo de malaria severa ocurre con mayor frecuencia en niños [1]. Así mismo, se pueden presentar casos de malaria cerebral, enfermedad que se da por la infección *P. falciparum* en el humano y puede desarrollarse tanto en niños como en adultos, siendo los niños los que presentan mayores complicaciones durante y después de la enfermedad, pues suelen presentar secuelas neurológicas graves a largo y corto plazo [3]. Lo anterior, indica que la malaria no solo representa un riesgo de salud pública para las comunidades, sino que también, genera grandes impactos económicos en las poblaciones, pues según la Organización Mundial de la Salud en el 2019 se reportaron aproximadamente 229 millones de casos de malaria a nivel mundial y un total de 409.000 muertes en todo el mundo de las cuales el 67% eran niños de alrededor de 5 años [4]. El objetivo de esta investigación es estudiar las dinámicas epidemiológicas y su efecto en la estructura genética de los parásitos de *Plasmodium falciparum* por medio de la evaluación de diferentes escenarios epidemiológicos. Lo anterior, con el fin de responder la pregunta de investigación ¿Cómo afecta la dinámica de transmisión de la malaria la estructura genética de los parásitos y la potencial emergencia de patógenos resistentes a los an-

timaláricos? En esta investigación se ha diseñado un modelo de agentes estocástico capaz de recopilar los mecanismos genéticos presentes en el proceso de infección en malaria, con el fin de obtener información sobre los cambios a los que se ven expuestas las poblaciones parasitarias a lo largo del tiempo. El modelo está diseñado a partir del algoritmo de Gillespie que nos permite resolver las ecuaciones estocásticas gobernantes del modelo. Esta aproximación permite obtener distribuciones poblacionales y analizar los posibles efectos que tiene la interacción de las poblaciones dentro de los vectores y los humanos. Por otro lado, los genomas parasitarios fueron diseñados a partir del análisis bioinformático de secuencias reales de la base de datos MalariaGEN, dichas secuencias nos permiten identificar en qué ubicación dentro de los cromosomas se tiene un evento de recombinación y así, disminuir la dimensionalidad del genoma para llevar a cabo su procesamiento dentro de las poblaciones del modelo. Esta aproximación nos permite analizar factores que posibilitan el establecimiento de genotipos resistentes a las medicinas convencionales, por medio de comportamientos humanos. Lo anterior con el fin de entender cómo afecta la dinámica de transmisión de la malaria, la estructura genética de los parásitos y la potencial emergencia de patógenos resistentes a los antimaláricos.

ID: 57

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Accidente ofídico en Colombia: ¿Cómo mejorar la disponibilidad de un valioso pero escaso tratamiento?

Carlos Andres Bravo-Vega, Camila Renji-fo-Ibañez, Leonardo Leon Nuñez and Juan Manuel Cordovez Alvarez

El envenenamiento por accidente ofídico es considerado como una enfermedad tropical desatendida por la organización mundial de salud debido a la poca investigación existente y a su alta carga sobre poblaciones rurales (1). El único tratamiento efectivo contra este problema es el suero antiofídico, pero su producción es costosa y no siempre se puede asegurar su disponibilidad en centros médicos (2–4). Colombia, al ser un país tropical y megadiverso, no es ajeno a esta situación, donde cada año alrededor de 4500 envenenamientos con 45 muertes son reportados al sistema de vigilancia SIVIGILA (5). El Instituto Nacional de Salud, parte del ministerio de salud, produce suero antiofídico a nivel nacional que está incluido dentro de los esquemas de salud pública. Aun así, este tratamiento no está siempre disponible en todos los centros médicos, y su distribución es basada en la compra de este insumo por los centros médicos y el stock disponible. De esta manera, el objetivo de este trabajo es el de mapear los centros médicos con la capacidad de atender un envenenamiento causado por serpientes, y de proponer distintos esquemas de distribución basado en modelos matemáticos: 1. Seleccionando 1 hospital por municipio, 2. Seleccionando todos los hospitales, pero definiendo una división que minimice el tiempo de viaje al centro médico más cercano, y 3. Una que defina hospitales especializados en el manejo del evento para reducir el número de centros a abastecer. Sobre estos esquemas, se calculó el tiempo máximo de desplazamiento a un centro médico por cada división, la demanda de sueros por cada división basado en la incidencia, y se estimó un costo asociado a la distribución de los sueros. Se encontró que la escala política, así sea la más adecuada a nivel administrativo, aumenta los costos y el tiempo de viaje de los pacientes siendo la menos

óptima. Además, se encontró que realizar una distribución centralizada de los sueros mejora la disponibilidad de estos, y los costos se pueden reducir significativamente al definir hospitales especializados. A futuro, se espera realizar una optimización y un análisis de costo/beneficio de cada esquema de distribución para poder brindar una herramienta centralizada que reduzca costos de distribución de sueros, garantice una mejor disponibilidad en los lugares donde se necesitan, y pueda ser fácilmente extrapolada a esquemas de distribución de otros tratamientos.

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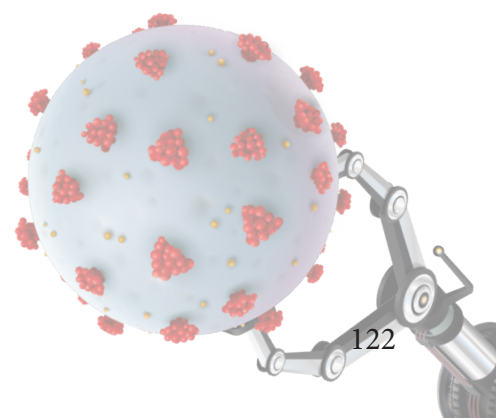
Modeling the impact of school's reopening and the effects of possible interventions in Bogotá, Colombia

Samuel Torres-Florez, Diana Higuera-Mendieta, Catalina Gonzalez-Urbe, Alf Onshuus, Juan Cordovez and Mauricio Santos-Vega

The COVID-19 pandemic has impacted the education sector across the world, especially for underdeveloped countries. The substantial restrictions avoiding classes in the schools' facilities to slow SARS-CoV-2 transmission have pushed to the virtualization of education. In LMIC such as Colombia, the technological barriers inherent in the most vulnerable socio-economic communities have had significant repercussions on child development, as children cannot attend their classes. Hence, evaluating and quantifying the real impact of reopening the schools under specific schemes (external interventions in different economic sectors, school occupation, ventilation within classrooms, usage of specific face masks) can be a valuable tool for policymakers. Our work provides alternatives to deploy interventions within schools to reduce the risk of infection and enable in-person education. We implemented a stochastic SEIR epidemiological on a contact network that recreates Bogotá's social structure in terms of household, schools, working, and community places. We calibrated and parameterized the model using public government data and epidemiological city-level and age-specific parameters inferred from multiple data streams. To represent the risk of infection in a classroom, we applied an aerosol transmission model, which considers environmental factors, physiological variables, and facemask efficiency. To accurately map the contact structure variation within a day, simulations occurring 8-hour intervals (a day divided into three stages). We do this to account for the network activity on the different day stages (schools/job places networks are primarily active on the second phase of the day). In our simulations, we analyze a variety of scenarios: The effect of contact reductions in each layer of the network; the outcome of

maintaining schools open and targeting the interventions to other layers; the benefit of implementing interventions within schools such as ventilation, face masks and adherence to restrictions in schools. Our results show that with a 35% of school capacity, there is no significant increase in the number of infections in any intervention scenario. In addition, we found that the uncontrolled easing of restriction may have a significant impact on the transmission. Our simulation shows that an occupation change from 50% to 90% in both community and workplaces involves around a 30% increase in the total of infected people. Furthermore, we showed that high ventilated classrooms combined with interventions around 40% in the external layer decreased the total number of infections from 48% to 9%. We then combined these factors with face masks efficiency and found that in low ventilation scenarios, there is a need for adherence and high filtering capacity (i.e., N95). In contrast, the type of face mask used in a high ventilation scenario has an indifferent over the transmission.

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Reducción de la varianza en los tiempos de espera en la asignación de trasplantes de riñón en la regional 1

Sergio Andrés Otero Solanilla and William Cruz Mususu

Se presenta un modelo de simulación discreta de la asignación de trasplantes de riñón en la regional 1 (R1) en Colombia. Los receptores entran al modelo de acuerdo con una tasa entre arribos y se albergan en una lista general de espera y una sublista de acuerdo con la Institución Prestadora de Salud (IPS) que les fue asignada. Los donantes entran al modelo de acuerdo con una tasa entre arribos, pero no todos son donante efectivo. De un donante efectivo se obtienen dos riñones que se asignan a los receptores en lista de espera de acuerdo con la política de asignación actual [1][2], la cual busca el mejor receptor en la lista de espera de acuerdo a características de los actores (Edad, Grupo Sanguíneo, HLA). El algoritmo de asignación de trasplante se desarrolla usando la información y lineamientos del Instituto Nacional de Salud (INS), los parámetros se estiman con la información oficial disponible [3] [4] y datos adquiridos en un modelo previo. El modelo actual de trasplantes colombiano se basa en un acceso a una justa oportunidad de trasplante para todos sus receptores y en obtener la mayor supervivencia del injerto/receptor. Con el objetivo de disminuir la varianza entre los tiempos de espera en la asignación de riñones en las diferentes IPS en la R1 se realizaron ajustes de los parámetros mediante un análisis de salida donde se verificó estadísticamente qué modelo refleja la dinámica deseada (Número de pacientes en lista, Trasplantes cadavéricos) intervalo de confianza del 90% en 1000 réplicas y se plantearon una serie de modelos alternativos para disminuir la varianza en los tiempos de espera del año 2008- 2018. Mediante estos modelos alternativos se espera analizar escenarios en que se genera una asignación más justa en términos de una menor variabilidad en tiempo hasta el trasplante en distintas IPS. De estos, el que mostró una menor variabilidad fue el de asignación de riñones a la IPS trasplantadora

más cercana con respecto a la IPS en la que se genera el donante, en este se observó una disminución del 20% de la variabilidad en los tiempos promedio de espera en las sublistas y de 13 días el tiempo de espera promedio en la lista de espera general durante el periodo de simulación. El número total aproximado de trasplantes cadavéricos efectivos durante el periodo de simulación y de pacientes en lista de espera al finalizar el último año de simulación es de 2500 y 2000 respectivamente. Este tipo de simulaciones permite evaluar los efectos de las distintas políticas de asignación en la trasplantabilidad de los pacientes y puede usarse como sustento para futuros cambios en las políticas de asignación o distribución en la R1.

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Multiphysics Simulation for the Personalized Treatment of Brain Tumors through Localized Hyperthermia using Magneto-thermic Nanoparticles

Danniel Moreno and Santiago Sánchez-Rentería

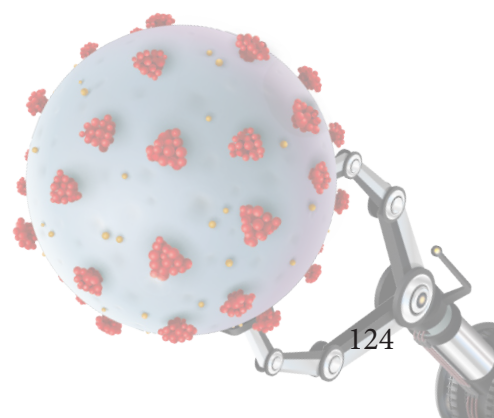
Localized hyperthermia has been shown to be a treatment that successfully contributes to tumor size reduction [1]. This treatment consists in elevating the tumor tissue temperature above approximately 41°C, inducing apoptosis and inhibiting tumoral cell proliferation [1]. A way of achieving a localized heat delivery in biological tissue is through applying a magnetic field over magneto-thermic nanoparticles, such as Super-paramagnetic Iron Oxide Nanoparticles (SPIONs), distributed around the region of interest [2]. Brain tumors are characterized by their heterogeneous shapes and sizes, which implies that it is very important to consider each patient's tumor geometry when planning the heat distribution applied during a localized hyperthermia treatment. This work establishes a pipeline to model the heat distribution during localized hyperthermia using magneto-thermic nanoparticles based on an initial segmentation of the patient's tumor over a magnetic resonance image (MRI). To model the geometry of the patient's brain and tumor, an original MRI and its respective tumor annotation were retrieved from the Brain Tumor Segmentation Challenge 2020 dataset [3] and were further processed using MATLAB and Autodesk MeshMixer to obtain an Standard Triangle Language (STL) file. Afterwards, this model was implemented in the COMSOL Multiphysics Software in order to simulate the heat transport phenomena generated by an SPIONs agglomeration under a magnetic field, modeled as a sphere with a superficial heat generation function. The heat distribution was compared between the implementation of a SPIONs sphere in the center of mass of the tumor, and two spheres manually located with the same surface area as the original sphere. The performance of the treatment was evaluated by the amount of randomly distribu-

ted surface points that achieved therapeutic temperature. MRI-to-STL conversion proved to be a functional methodology for the physical modeling of tumor geometries. The model of the manually located spheres showed a better performance under certain specific magnetic field properties, which confirms the importance of a personalized geometry study during the planning phase of such treatments. In the final analysis, this work suggests the coupled use of MRI-based tumor segmentation algorithms and multiphysics computer simulations as a promising approach for the planning of personalized treatments and procedures.

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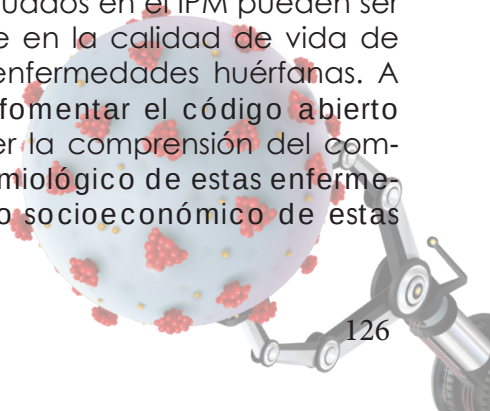
Logística Hospitalaria

Georreferenciación y caracterización de pacientes con enfermedades huérfanas de Pereira atendidos en un centro hospitalario de cuarto nivel

Diego Mauricio Gomez Londoño, Ángela Patricia López, Hernan Felipe Garcia Arias, Jorge Mario Estrada Álvarez and Gloria Liliana Porras Hurtado

Las enfermedades huérfanas-raras constituyen un grupo amplio y variado de trastornos que afectan una proporción baja de la población, se caracterizan por su cronicidad, complejidad, compromiso sistémico y alta mortalidad. En el mundo se han identificado entre 6000 y 7000, mientras que en Colombia legalmente se reconocen 2149. El objetivo de este estudio fue realizar la georreferenciación y la caracterización de los pacientes atendidos en un centro hospitalario y su relación con el Índice de Pobreza Multidimensional (IPM) para la ciudad de Pereira. Se realizó un estudio descriptivo de corte transversal para identificar las características y la distribución espacial de las enfermedades huérfanas en la ciudad de Pereira, a partir de la información de un centro hospitalario de referencia en el centro occidente colombiano. Para ello, se utilizó la información de residencia de los pacientes con el fin de identificar sus coordenadas geográficas y el valor del IPM asociado a la manzana de residencia dado por el Censo Nacional de Población y Vivienda del 2018 realizado por el Departamento Administrativo Nacional de Estadística. Además, se utilizó Python 3 mediante la librería Folium en para la creación de mapas en formato HTML que permite la visualización interactiva y la geolocalización de la distribución de la información (ej. Puntos de calor), también se usó la librería Geoplot para la Estimación de la Densidad de Kernel (KDE) para hallar la distribución de probabilidad de ocurrencia de una enfermedad en un área y su relación con el IPM. Se identi-

caron 516 pacientes donde se estableció una prevalencia de base hospitalaria de 10.8 enfermedades por cada 10000 habitantes (IC del 95%: 9.88 – 11.75). Las mujeres representaron el 53,88% de los pacientes y los hombres el 46,12%, la mediana de la edad fue de 25 años. Así mismo, se registraron 116 enfermedades diferentes; las más frecuentes fueron: Enfermedad de Von Willebrand (17,25%), Púrpura trombocitopénica inmunitaria (6,78%) y Distrofia muscular (6,59%). Las enfermedades fueron agrupadas por grupos nosológicos, en los cuales, las enfermedades congénitas, malformaciones y alteraciones cromosómicas fueron frecuentes entre los menores de 17 años. Además, las enfermedades del sistema hematológico fueron más comunes entre los pacientes con edades entre los 18 y los 64 años y, las enfermedades del sistema respiratorio presentaron mayor frecuencia en los mayores de 65 años. Los mapas interactivos se presentaron como una herramienta para visualizar la distribución de las enfermedades en el municipio, donde se pueden observar puntos de calor dados por la cantidad de pacientes que se encuentran dentro de un área. Sumado a esto, se creó un mapa donde el IPM se presenta como un mosaico por medio de las comunas, y en combinación con la KDE, se evidencian las posibles dificultades socioeconómicas que pueden presentar los pacientes dependiendo el sector de residencia. Se presenta el panorama de las enfermedades huérfanas para el municipio de Pereira, además del desarrollo de mapas que permiten visualizar la distribución de diferentes grupos de enfermedades. Se resalta la utilidad de la georreferenciación como una herramienta que brinda información a centros médicos y administrativos, con el fin de ayudar en la planificación de la salud y la generación de políticas públicas; puesto que se evidencian estructuras subpoblacionales que agrupan distintas enfermedades y cuyas condiciones educativas, de la niñez y juventud, de la salud, del trabajo, y de la vivienda y servicios públicos evaluados en el IPM pueden ser un factor influyente en la calidad de vida de las personas con enfermedades huérfanas. A futuro, se plantea fomentar el código abierto con el fin fortalecer la comprensión del comportamiento epidemiológico de estas enfermedades y el impacto socioeconómico de estas en la comunidad.



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Risk Factors Assessment Associated with Hospital-Acquired Infections Using Biomedical Equipment in High Complexity Health Care Institutions: a Systematic Review

Karen Tatiana Valencia Rivero, Jair Tellez, Yeison Arévalo, Juan Escobar and Lina Vargas

Hospital-acquired infections (HAI) are infections acquired by patients while attending health care centers [1]. According to the WHO, these infections are the most common adverse events in health care services [2]. The aim of the present study was to carry out a systematic review to determine the risk factors associated with hospital-acquired infections due to the use of biomedical equipment in high complex health care services. Systematic review of literature was based on the search of electronic available manuscripts in EBSCO, Scopus, and Web of Science databases. Literature was selected according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses methodology (PRISMA), using the NVIVO software for further analysis [3]. A Mixed Methods Assessment Tool matrix (MMAT) was used allowing the evaluation of the methodological quality of five types of studies: qualitative investigations, randomized controlled trials, non-randomized studies, descriptive quantitative studies, and mixed method studies. In the review 797 articles were found (EBSCO 44, Scopus 544, Web of Science 209), 63 duplicates were found and excluded. In the selection process 7 articles were excluded by language and 609 after examining the title and abstract. In the full text evaluation, 57 articles were included for the mixed analysis. Results showed that the main risk factors associated with the hospital-acquired infections using biomedical equipment were the exposure time to mechanical ventilation (OR: 3.76; 95% CI, 1.41-10.02), reintubation (OR: 3.075; 95% CI, 0.841-1.235), and tracheostomy (OR: 2.669; 95% CI, 1.073-6.634) [4]. Most frequently studied HAI was the Ventilator-associated Pneumonia

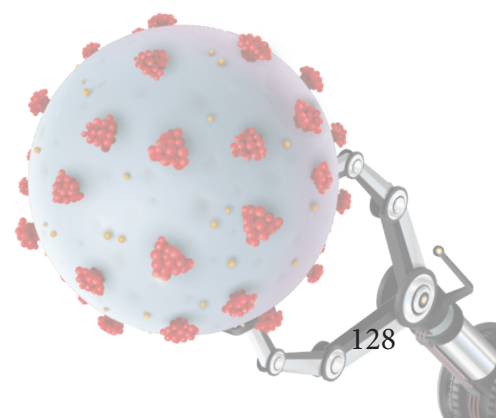
(VAP) [5], which presented rates of alarming incidence and mortality regardless of the country, demonstrating that The HAI associated with biomedical equipment is a major problem in the health services in some countries such as Cuba, Spain, or France where the mortality rate is over 40% [5], [6], [7]. Similarly, sanitary barriers were identified as one of the measures that can be useful to maximize patient safety against VAP and infectious pathogens due to contamination caused by a lack of cleaning of areas prone to bacterial growth or the use of mechanical ventilation for prolonged periods, which increases the likelihood of developing VAP. Among the main sanitary barriers to prevent VAP, literature highlighted activities such as the implementation of measures including patient's head elevation at least 30°, establishment of oral care protocols, modification of the ventilator circuit parameters (specially draining condensation at least every 2-4 hours), adequate storage of oral suction devices, and strict hygiene protocols [8], [9]. It is concluded that there are few studies focused on HAI related to equipment biomedical facilities different to ventilators and it was also evident that the studies conducted in the surgery service are minimal compared to those performed in the Intensive Care Unit (ICU) [6], [8]. This systematic review did not find indexed published studies carried out in Colombia, reason why we suggest for further research to include research made at college level to have a more solid data base about this problem in Colombia.

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2^{do} CONGRESO INTERNACIONAL
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Señales

Classification of upper limb grips with bioelectrical EMG and EEG signals with artificial intelligence techniques

Fabian David Barreto Sanchez, Cesar Andrey Perdomo Charry and Julian Rolando Camargo López

Brain-computer interfaces (BCIs) provide a connection between the human brain and a computer. BCI systems capture neural activities associated with external stimuli or mental tasks, without involving nerves or muscles, and provide alternative non-muscular communication. Interpreted brain activities are translated directly into a script to perform specific tasks, such as controlling wheelchairs, appliances, robotic arms, speech synthesizers, computers, and gaming applications. The level and pattern of neuromuscular activity can be measured by electromyography (EMG) during specific movements. As such, EMG measurements would be valuable in determining muscle stimulation during the different modes of generating gestures, orientation, position, and insertion angles of the upper extremities. These signals contain highly revealing information in everyday upper extremity gestures. This research article aims to develop artificial intelligence models for bioelectric signals (encephalographic and myoelectric), where the main characteristics of each signal are identified and the best computational model for each signal is established, for which tests are implemented with these acquisition devices from a study with real patients and subsequent processing to extract the characteristics of the bioelectric signals.

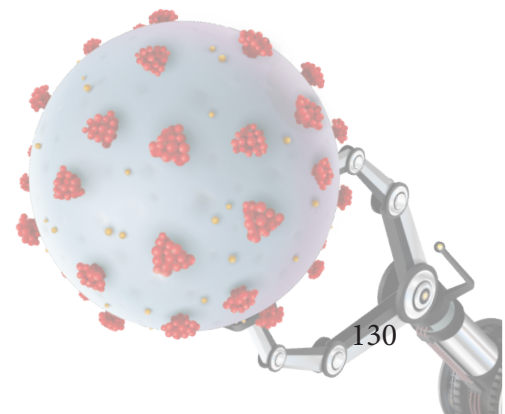
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Development of a low-cost surface EMG acquisition system device for wearable applications

Edgar González, Mario Valderrama and Fernando García

Currently, the study of electromyographic signals (EMG) has allowed the development of diverse applications in, clinical and biomedical fields. For instance, EMG signals has served as inputs for different types of human-machine systems. However, the process for the acquisition of this type of biosignals presents some inconveniences associated with the degree of invasiveness, the use-convenience balance, and the range of portability. For this reason, in this study we designed and validated a wearable and portable system for the acquisition of surface Electromyography (sEMG) signals for the upper limbs. The design consisted of an adaptable arm-forearm cuff (not invasive), allowing different electrode distributions for signal acquisition. We tested our prototype with the OpenBCI board through several experimental protocols, obtaining high levels of ergonomics and signal quality. With this development we expect to the acquisition of EMG signals that could be integrated to different human-machine systems such as EMG prostheses.

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How do factors of comfort, concentration, and eye fatigue affect the performance of a BCI system based on SS-VEP?

Cristian David Guerrero Mendez, Cristian Felipe Blanco Diaz and Andrés Felipe Ruiz Olaya

In this article, a comparative study is implemented to determine how physical or mental factors affect the performance of a SSVEP-BCI system. For this, a public EEG dataset was used that consists of four flickering rectangles on a led screen (5.45, 6.67, 8.57 and 12 Hz). During the experimental design subjects answered a questionnaire to determine their physical and mental conditions in the acquisition of EEG signals. The factors of comfort (high and low), concentration (high and low) and eye fatigue (high and low) were evaluated by selecting 2 groups each one with 8 different subjects to each factor evaluated. In order to identifying target frequency components using EEG signals, it was implemented the Filter Bank Canonical Correlation Analysis (FBC-CA) algorithm using five occipital lobe EEG channels. The performance was quantified by means of accuracy (Acc) and Information Transfer Rate (ITR) metrics. Furthermore, a statistical analysis was performed to determine whether better results are presented when a subject presents high comfort, high concentration or low eye fatigue. According to obtained results, it were found changes for Acc and ITR according to factor of comfort, concentration and eye fatigue of the subjects. However, statistically there are no significant differences ($p > 0.05$) in the physical or mental factors analyzed for 4 different time windows implemented.

ID: 31

Spatio Temporal Filtering of Multi-lead ECG Signal for Atrial Arrhythmia Classification

Sonia Contreras Ortiz, Jader Giraldo Guzmán, Marian Kotas and Francisco Castells

Atrial fibrillation (AF) is the most common cardiac arrhythmia and increases the risk of suffering stroke. Some people with AF do not have symptoms, so, its diagnosis can be difficult, especially in early stages of the disease. In this paper, we propose the use of the spatio-temporal filter (STF) to characterize atrial activity in ECG recordings and distinguish between normal sinus rhythm (NSR) and atrial arrhythmias. This method allows the effective detection of P waves when they are synchronized with QRS complexes. The distances from the QRS complexes to the detected P waves are characterized by seven dispersion metrics that are used as inputs to three clustering algorithms. The results show classification accuracy of up to 98.88% of NSR and atrial arrhythmias.

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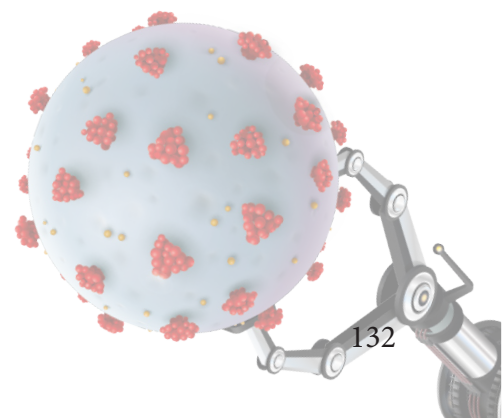


Ultra-short-term analysis of heart rate variability for epileptic seizures prediction

Alejandro Paredes, Ignacio Buscema and Erick Arguello

Epilepsy affects over 50 million people worldwide, and it is characterized by seizures that, when uncontrolled, may cause serious injuries to patients and people around them. An important proportion of epileptic patients responds poorly to medication or does not receive adequate treatment, so a seizure prediction system could contribute to improving their quality of life. Current seizure prediction approaches are mainly based on the use of video-electroencephalography (EEG), which may be unrealistic for home and ambulatory monitoring. Since abnormal epileptic activity in the brain also can affect brain regions controlling autonomic activity, fluctuations in cardiac activity may reflect such anomalies. Previous studies report significant differences between time- and frequency-domain heart rate variability (HRV) measures calculated near and far from seizure onsets, thereby suggesting that HRV could be useful for predicting seizures. However, those differences were observed around 3-30 min before seizure onsets, thereby suggesting that patients have to wait for the same time before determining whether a seizure will occur or not. As an alternative approach, this work aims to examine the feasibility of using ultra-shortterm HRV (i.e., 1-min ECG recordings) for seizure prediction. ECG recordings from seven epileptic patients were used, and time- and frequency-domain HRV measures were extracted from twenty 1-min length segments previous to seizures onset. RMSSD, SDNN/RMSSD, and LF mean values showed significant differences ($p < 0.05$) 1 minute before the seizure, which suggests that patients may have little time to ensure their safety. Future research endeavors may include exploring how suitable are nonlinear HRV indexes as epileptic seizures predictors.

ID: 24



Design of a user interface to study the effects of Ph regulation through the respiratory system

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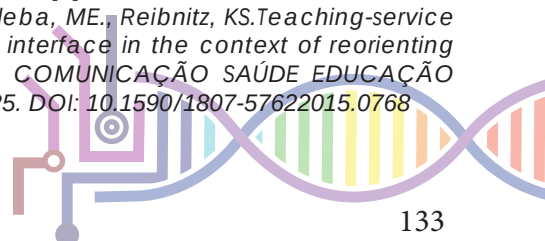
The intracellular and extracellular environment is strictly regulated by the different homeostatic mechanisms of the body. The acid balance is modulated by chemical and physiological buffering mechanisms that prevent sudden changes in pH. One of these mechanisms is carried out by the respiratory system, which is in charge of controlling variables such as the pressure of CO₂ and the levels of hydrogen ions. Further, this function is mediated by central and peripheral nerve centers. The objective of the study was to design an interface that allows users, focused on second year engineering students, to familiarise and to represent the dependence between the variables that control acid-base regulation through ventilatory responses. To achieve this goal we use the following methodology: 1. To choose the software; 2. To identify the respiratory system variables; 3. to relate the variables in the respiratory system with pH; 4. To obtain a functional interface. App Designer was used as a complement to Matlab to show the changes in the behavior of the respiratory system. First, the interface for the representation of acid-base balance and responses through the respiratory system was designed with the use of the previously described tool. Subsequently, we proceeded with the identification of the respiratory variables and their effect on pH control were identified; for this, a review of the research carried out in the field was made, taking into account the level of participation both at the nervous and at the respiratory system level. Then, the user interface was drafted in App Designer, which was the basis for the development of the interface. Finally, the variables were simulated

and their behavior was analyzed. As a result, an interface was obtained in which the standard levels of pH concentration, CO₂ pressure and Bicarbonate concentration are shown due to the fact that these are presented as the most relevant variables of the process. There is a section in which the user can modify the state of either alkalosis or acidosis. Once selected, the results are described by two methods; one graph in which the number of breaths are contrasted on the abscissa and the respiratory volume on the ordinate axis in an interval of one minute. The other representation method is based on indicators that show the level of participation of each variable, in addition to the respiratory center of the nervous system responsible for the physiological process. At the end of the interface, it briefly describes the selected mechanism and how the respiratory system works with instruction points distributed throughout the interface to facilitate the understanding of its functioning. According to the literature review it was determined that the respiratory system is controlled by the nerve centers modifying the respiratory rate and the amplitude of respiration, because it has a greater effect on modifying the acid-base balance in the body. Once the user uses the interface it may let them conclude that alterations in pH will cause the organism to respond with certain regulatory mechanisms, these changes and relationships between variables can be represented interactively and directly with technological tools where the levels of regulation of an alkalosis and acidosis are simulated.

ID: 22

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Simulación de una silla de ruedas controlada por señales EEG

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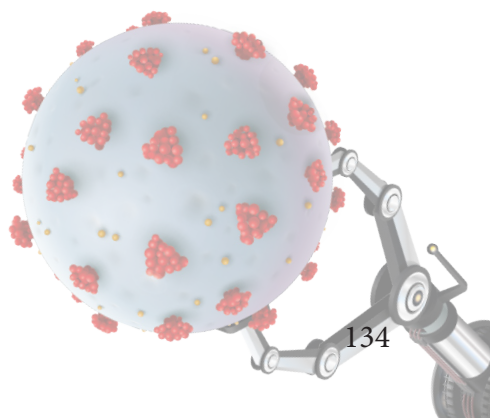
La parálisis cerebral es un trastorno motor incurable que afecta entre uno y cuatro de cada mil niños [1]. Este trastorno altera la movilidad, el control, los reflejos, y/o el tono muscular de quien la padece, limitando de esta manera su desplazamiento y autonomía [2]. Dependiendo del tipo de parálisis, se requieren ayudas que permitan a los niños movilizarse al no poder usar sus extremidades. En investigaciones previas se han propuesto sillas de ruedas con interfaz cerebro computadora y se han simulado para diferentes entornos, sin embargo, casi ninguna es capaz de superar obstáculos y seguir trayectorias esperadas [3]. El presente trabajo tiene como objetivo diseñar y simular una silla de ruedas eléctrica controlada a partir de señales electroencefalográficas (EEG). Se diseña la silla considerando las medidas antropométricas de un niño de siete años, con parálisis cerebral espástica y síndrome de tijera. El desplazamiento de la silla se logra a través de un sistema basado en piñones y cadenas, que están acoplados a dos motores DC para mover de forma independiente dos ruedas de tracción. Estos motores serán controlados por las señales provenientes de un sistema Emotiv, con marcado CE y registro FCC ID para protección del paciente. Para simular los movimientos de la silla controlados a través de la señal EEG, se emplea una señal de la base de datos Physionet [4] que es filtrada para obtener las ondas beta y de la que se extraen con el software Polymath las lecturas de los pares de electrodos C3-P3, CZ-PZ, C4-P4 y T8-P8, correspondientes a la corteza motora en estado de actividad consciente. Por último, a cada par se le asigna un rango de voltaje según los puntos máximos de la señal, para el control de avanzar, detener y giros derecha e izquierda, respectivamente. – En la simulación se obtuvo que la silla puede movilizarse con velocidades inferiores a 7m/s

sobre diferentes superficies y con desniveles de hasta 3cm. De manera experimental, hubo un desfase de 392ms entre la salida de la interfaz y el movimiento de los motores controlados por EEG, lo cual, permite seguir trayectorias adaptándose rápidamente al entorno. Sin embargo, en el modo manual, se presenta un desfase de aproximadamente 2s. Por otro lado, al usar Webots como entorno de simulación, es posible tener un acercamiento más real debido a la posibilidad de configurar condiciones físicas como choques y gravedad.

ID: 60

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Frequency domain signal quality index in swallowing-related surface electromyography

Julio Jimmy Cuadros Acosta and Andrés Felipe Orozco Duque

Dysphagia is a swallowing disorder that has a high incidence worldwide. Recent approaches aim to develop noninvasive techniques based on surface electromyography (sEMG) [1]. Although these approaches have shown potential to assess the coordination of muscle activity in the detection and screening of dysphagia, it has been found that the sEMG signal analysis in dysphagia is sensitive to low signal-to-noise ratio (SNR) due to multiple factors (e.g., data acquisition system, noise contaminants, power frequency line, etc.) [2]. To assess the noise in sEMG signals, multiple quality estimators have been proposed, which are referred to in the literature as: "Signal quality index" (SQI) [3][4]. Our approach aims to propose an SQI to achieve the detection of poor quality sEMG signals based on the frequency domain. We proposed an SQI that measures if the distribution of power spectral density (PSD) is concentrated in few peaks, some of them can be harmonics of power frequency line. However, there are other sources of noise with harmonics that can be present in the signal. The SQI developed in this study can be referred to as "peaks of PSD" (PSDpeaks). To compute the SQI; first, we estimate the PSD (Welch method with a 1024 points window). Second, we measure the maximum value of the PSD and counted how many points are above the 10% of the maximum value. We hypothesize that the signal has poor quality if the PSD is centered in few peaks and the value of PSDpeaks is low. Contrary, if the signal has a high SNR, the PSD is widely distributed in the bandwidth of the EMG signals and the value of the PSDpeaks is higher. We compare the proposed SQI with another SQI based on the estimation of the PSD centered at the power line frequency and its harmonics (PSD_60Hz). To compute the SQI, we measure an estimation of the percentage of power centered at 60Hz, 120Hz, and 180Hz with a bandwidth of 2Hz. For this study, a dataset was built including 304 signals from a database of patients diagnosed with dysphagia, sampled to 2kHz with a 24-bit resolution. The protocol and the acquisition setup are described in a previous study by Roldan et al., [1].

We manually divided the data set into two equal groups of 152 signals labeled as poor and good quality by visual inspection based on the power spectral density, spectrogram, and histogram plots. A signal was considered of poor quality if the presence of a noise contaminant distorted most of the signal and prevented the differentiation of at least one muscle activation. Afterward, we tested and compared the performance between the raw and filtered signals (10Hz500Hz fifth-order Butterworth filter; 60Hz notch filter). The area under the receiver operating characteristic (ROC AUC) was used to measure the performance of the SQIs. Results: The proposed SQI achieved a ROC AUC of 0.9759 for the raw signals and 0.9801 for the filtered signals. On the contrary, PSD_60Hz reaches 0.87 ROC AUC using only the power centered at 60Hz, and it does not have a good performance in filtered signals, where using harmonics at 120Hz, and 180Hz only reached a maximum value of 0.6485 ROC AUC. In this dataset the optimal cut-off point for PSDpeaks is 30, this value is the threshold to decide if a signal is classified as poor or good quality. In conclusion, the implementation of the proposed scheme can help to fill the knowledge gap regarding the implementation of robust strategies to validate sEMG signal quality analysis. The proposed PSDpeaks distribution estimator can distinguish a bad quality signal with high performance. In future studies, this SQI could be applied as a pre-processing step to improve the performance of sEMG signal studies in swallowing tasks.

ID: 81

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