UNIVERSIDAD AUTÓNOMA DE BAJA CALIFORNIA

COORDINACIÓN GENERAL DE FORMACIÓN BÁSICA
COORDINACIÓN GENERAL DE FORMACIÓN PROFESIONAL Y VINCULACIÓN UNIVERSITARIA
PROGRAMA DE UNIDAD DE APRENDIZAJE

I. IDENTIFICATION INFORMATION

1. **Academic Unit**: Faculty of Engineering, Mexicali; Faculty of Engineering, Architecture and Design, Ensenada and School of Sciences of Engineering and Technology, Valle de las Palmas.

2. **Study Program(s):** Bioengineering

3. **Plan Duration:** 2020-1

4. **Name of Learning Unit:** Biomaterials

5. **Code**: 36242

6. **HC:** 01 **HL:** 02 **HT:** 01 **HPC:** 00 **HCL:** 00 **HE:** 01 **CR:** 05

7. **Learning stage to which it belongs**: Disciplinary

8. **Character of Learning Unit**: Obligatory

9. **Requirements for enrollment in learning unit:** Bioquímica

UNIVERSIDAD AUTÓNOMA DE BAJA CALIFORNIA
REGISTRADO
22 MAR 2019
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COORDINACIÓN GENERAL DE FORMACIÓN BÁSICA

PUA Formulated by:	**Signature**	**Approved by**	**Signature**
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Luis Jesús Villarreal Gómez		Humberto Cervantes de Ávila	
Ana Leticia Iglesias		María Cristina Castañón Bautista	
Mónica Isabel Soto Tapiz			

Date: October 30 2018

III. COURSE COMPETENCIES

Integrate the chemical properties of materials and their clinical applications, by identifying the properties of biomaterials, to propose their application in the manufacture of appropriate biomedical devices and in green technologies with a respectful and patient attitude towards living beings and their environment.

IV. EVIDENCES OF PERFORMANCE

1. Prepares and delivers a documentary research that deals with the subject of the applications of biomaterials and develops a proposal that describes the necessary properties that a biomaterial must contain to fulfill a specific function. Must meet the following requirements: background, state of the art, description of the proposal, conclusion and references.

2. Portfolio of evidence that integrates the following reports:

- Laboratory practices that include the reports of the experimental developments that include the sections of introduction, objective, theoretical framework, methodology, results, conclusions and references.
- Resolution of exercises and activities carried out in the workshop.

V. COURSE CONTENT DISTRIBUTION

UNIT I. Biomaterials properties

Competence:
Acquire the ability to define a biomaterial and recognize its most important properties, through the evaluation of its physicochemical and mechanical characteristics, with honesty and work in collaboration with his classmates.

Content: **Duration:** 2 hours

1.1. Properties of materials
- 1.1.1 General properties of biomaterials
- 1.1.2 Elemental analysis
- 1.1.3 Surface properties and characterization of biomaterials
- 1.1.4 Role of water in the properties of biomaterials

1.2. Mechanical properties
- 1.2.1. Tension
- 1.2.2. Compression
- 1.2.3. Cutting tension (shears)
- 1.2.4. Flexion
- 1.2.5. Viscoelasticity
- 1.2.1. Fracture
- 1.2.2. Fatigue

UNIT II. Biomaterials classification

Competence:
List the types of biomaterials, through an exhaustive analysis of the properties and characteristics of each material, to apply it to the design of bioengineering devices, with an attitude of tolerance and respect towards living beings.

Content: **Duration:** 3 hours

2.1. Natural and synthetic polymers
- 2.1.1. Polymers
- 2.1.2. Silicone biomaterials
- 2.1.3. Medical fibers and bio textiles
- 2.1.4. Hydrogels
- 2.1.5. Natural materials
- 2.1.6. Ceramics
- 2.1.7. Biomolecules immobilized to surfaces

2.2. Ceramic
2.3. Metals
2.4. Composites

UNIT III. Role of blood in repair of wounds and fractures

Competence:
Understand the mechanisms of tissue repair, as well as the role played by the different blood components in these processes, through the comparison between tissue regeneration and healing, with a respectful attitude towards the complexity of living beings.

Content: **Duration:** 4 hours

3.1. Repair of wounds and fractures
- 3.1.1. Proteins adsorbed on tissue response materials
- 3.1.2. Cells and tissue damage
- 3.1.3. Interaction of biomaterials with tissues and the extracellular matrix
- 3.1.4. Mechanical forces on cells

3.2. Blood clotting
- 3.2.1. Inflammation, wound healing and body response to foreign agents
- 3.2.2. Natural and acquired immunity: the immune response to foreign materials
- 3.2.3. The complement system
- 3.2.4. Blood coagulation and interaction of materials with blood

UNIT IV. Biomaterials biocompatibility

Competence:
Relate the physicochemical and mechanical properties of biomaterials with their biological behavior towards tissue or living organisms, analyzing the degradation processes of the material and evaluating the effect it has on the different types of cells and tissues, with the purpose of selecting the appropriate type of biomaterial necessary for each specific application, with sensitivity towards living beings and the environment.

Content: **Duration:** 3 hours

4.1. Materials degradation in the environment
- 4.1.1. Chemical degradation and biochemistry of polymers
- 4.1.2. Degradative effects of the biological environment on metals and ceramics
- 4.1.3. Pathological calcification of biomaterials

4.2. Biocompatibility
4.2.1. *In vitro* evaluation of tissue compatibility
4.2.2. *In vivo* evaluation of tissue compatibility
4.2.3. Evaluation of interactions of biomaterials with blood (Hemocompatibility)

UNIT V. Biomaterials applications

Competence:
Deduce the utility of a biomaterial based on its classification, properties and behavior, for its application in medical devices or tissue engineering, listing the patents and technological advances where these materials are applied, recognizing this area as multidisciplinary, with an interest for the science and discernment of the importance of biomaterials in the world of the 21st century that surrounds us.

Content: **Duration:** 4 hours

5.1. Artificial organs and medical devices
- 5.1.1. Non-thrombogenic treatments and strategies
- 5.1.2. Cardiovascular devices
- 5.1.3. Implantable cardiac devices
- 5.1.4. Artificial blood and erythrocyte substitute
- 5.1.5. Dressings for burns and skin substitutes

5.2. Technology Engineering
5.2.1. Current overview of tissue engineering
5.2.2. Immunoisolation
5.2.3. Resorbable synthetic polymer scaffolds

VI. STRUCTURE OF WORKSHOP PRACTICES				
Practice No.	**Competence**	**Description**	**Support material**	**Time**
UNIT I				
1	Compare techniques of chemical analysis, for the characterization of biomaterials, through the graphic representation of ideas with objectivity.	Search for characteristics of chemical analysis techniques (HPLC, infrared, spectrophotometry, contact angle, chromatography, etc.) in databases and preparation of synoptic tables, mental maps, etc.	Databases, calculator, notebook, educational platform.	2 hours
2	Calculate specific parameters to determine the mechanical properties of a biomaterial, by applying formulas and concepts with an analytical and collaborative attitude.	Resolution of theoretical exercises for the calculation of elasticity, fracture tenacity, analysis of stress-strain curves.	Databases, calculator, notebook, educational platform.	2 hours
UNIT II				
3	Apply the theoretical concepts about the polymerization mechanisms, for the resolution of theoretical exercises, through the use of formulas and specific calculations with objectivity and responsibility.	Resolution of exercises where the Mn, Mw, polymerization time, degree of polymerization was calculated. Analysis of structures and types of links.	Databases, calculator, notebook, educational platform.	2 hours
4	Identify the particular characteristics of ceramics to evaluate their use in biomedical devices, by analyzing their chemical composition with organization and team collaboration.	Chemical composition analysis reported in the bibliography of ceramics used in the medical industry and those that are in development.	Databases, calculator, notebook, educational platform.	2 hours

5	Determine the possible risks of the use of metals as biomaterials, to propose alternatives for the development of these, through the resolution of redox exercises with an analytical attitude and respect for living beings.	Resolution of theoretical-practical exercises where the oxidation capacity of metals is evaluated.	Notebook, calculator, educational platform.	2 hours
UNIT III				
6	To identify the effects of biomaterials on biological fluids, to evaluate their application in biomedical implants, through the analysis of type cases reported in literature with a critical attitude and respect to living beings.	Analysis of typical cases where effects of the biomaterial-blood interaction provided by the facilitator are identified.	Notebook, educational platform, publications with standard cases.	2 hours
7	Determine the coagulation times of human blood to know the effect of biomaterials on coagulation, by calculating the times of agglutination of proteins with organization and discipline.	Resolution of theoretical exercises where the coagulation times are calculated from data provided by the facilitator.	Notebook, calculator, educational platform.	2 hours
8	Analyze the biocompatibility tests, to evaluate the possible use of a biomaterial as the basis of a biodevice, by searching for the compatibility tests allowed in the current Norms, with disposition and social commitment	Search for current biocompatibility tests and analysis of these to identify when they are applicable and under what conditions.	Notebook, calculator, educational platform.	2 hours

VI. STRUCTURE OF LABORATORY PRACTICES				
Practice No.	**Competence**	**Description**	**Support material**	**Time**
UNIT I				
1	Analyze the characteristics of medical devices, through the exploration of databases available on the Internet, to know both the medical devices that exist, and the biomaterials most used today, with a research, analytical and careful attitude of the construction details of the biodevices.	Explore in the databases the FDA page, select some biodevices and list their characteristics.	Computer, internet, data processor, educational platform.	2 hours
2	Measure and interpret the properties of biomaterials, through the use of chemical analysis techniques, to obtain information on the chemical nature of the biomaterial, with a critical attitude and interest in relationships between structure-function.	Use the chemical analysis technique indicated by the facilitator to measure and interpret the properties of the biomaterial provided.	Basic laboratory material (test tubes, beakers, pipettes), calculator, notebook, spectrophotometer (optional), infrared (optional).	4 hours
UNIT II				
3	Investigate the optimal reaction conditions, applying fundamentals of organic chemistry, physiochemistry and biochemistry, to obtain microspheres of a biopolymer useful in the immobilization of cells and enzymes, as well as in the delivery of medication, showing interest and responsibility when solving current problems of the medicine.	Obtain a biopolymer (alginate) by treating the raw material (seaweed) to extract a product usable as a biomaterial.	Seaweed, formalin, 1N HCl, Na_2CO_3, pHmeter, basic laboratory material (test tubes, beakers, pipettes).	4 hours

4	To evaluate the capacity of hydrogels to absorb water, through their exposure to different aqueous solutions with an innovative and objective attitude.	Exposure of contact lenses (hydrogels) to different aqueous solutions in order to determine the change in shape and volume.	Contact lens, vinegar, baking soda, basic laboratory material (test tubes, beakers, pipettes).	2 hours
5	Measure the viscosity of a biomaterial, by using a viscometer, to evaluate the quality of a polymer and the possibility of its use in the production of microspheres, to bioencapsulation, with an analytical and critical attitude.	Measure the viscosity of a polymer provided by the facilitator.	Basic laboratory material (test tubes, beakers, pipettes), polymer, calculator, notebook.	3 hours
6	Analyze the benefits of a biomaterial, for the preparation of a medical device (microspheres for the delivery of medicines), by evaluating the homogeneity of the product, with a critical attitude in the review of characteristics of weight and size.	Prepare alginate microspheres, measure the diameter, weight and volume used to make each sphere.	Basic laboratory material (test tubes, beakers, pipettes), calculator, vernier, notebook.	3 hours
7	Synthesize hydroxyapatite nanoparticles, by the method of co-precipitation, to acquire dexterity in the recognition of the characteristics of a biomaterial used in medicine, with objectivity and interest for the possible uses of the product.	Synthesis of hydroxyapatite by the precipitation method.	Basic laboratory material (test tubes, beakers, pipettes), phosphoric acid, calcium hydroxide, ammonium hydroxide, calculator, notebook.	4 hours
UNIT III				
8	Calculate the Ca / P ratio in a sample of hydroxyapatite, by quantifying the content of Ca and by chemical methods, to	Determine the concentration of Ca and P by spectrophotometric methods and calculate the Ca / P ratio.	Water bath, basic laboratory material (test tubes, beakers, pipettes), pH meter, NaOH, sulfuric acid, spectrophotometer.	4 hours

	evaluate the purity and identity of the bioceramic, with an analytical and proactive attitude.			
9	To carry out an addition polymerization, through the use of methyl methacrylate as a monomer, to obtain a synthetic biopolymer, with a critical and innovative attitude.	Obtain a polymer from monomers by addition polymerization.	Water bath, basic laboratory material (test tubes, beakers, pipettes), thiamine hydrochloride, sodium hydroxide.	4 hours
UNIT IV				
10	Determine the time of blood coagulation, by exposing the biological fluid to a biomaterial, to determine its effect with a critical and objective attitude.	Expose a blood sample to the biomaterial that the facilitator determines.	Basic laboratory material (test tubes, beakers, pipettes), blood sample.	2 hours

VII. WORK METHOD

Framing: The first day of class the teacher must establish the form of work, evaluation criteria, quality of academic work, rights and obligations for teacher and students.

Teaching strategy (teacher)
Case study, project method, problem-based learning, expository technique and practical exercises

Learning strategy (student)
Documentary research, case studies, teamwork, exhibitions, graphic organizers, resolution of exercises.

VIII. EVALUATION CRITERIA

The evaluation will be carried out permanently during the development of the learning unit as follows:

Accreditation Criterion

- To be entitled to ordinary and extraordinary exam, the student must meet the attendance percentages established in the current School Statute.
- Scaled from 0 to 100, with a minimum approval of 60.

Evaluation criteria

- Evidence of performace 1……..25%
- (Socumentary research)
- Evidence of performance 2…….35%
- (Evidence portafolio)
- Partial evaluations (2)……..40%

Total……100%

IX. REFERENCES

Required

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Reviews, C. T. I. (2016). *Biomaterials, The Intersection of Biology and Materials Science: Biology, Biotechnology.* Cram101. Retrieved from https://books.google.com.mx/books?id=J4-d8ZsLfBAC

Shi, D. (2013). *Biomaterials and Tissue Engineering*. Springer Berlin Heidelberg. Retrieved from https://books.google.com.mx/books?id=y278CAAAQBAJ

Thomas, S., Balakrishnan, P., & Sreekala, M. S. (2018). *Fundamental Biomaterials: Polymers*. Elsevier Science. Retrieved from https://books.google.com.mx/books?id=q084DwAAQBAJ

Williams, D. (2014). *Essential Biomaterials Science*. Cambridge University Press. Retrieved from https://books.google.com.mx/books?id=bjWzAwAAQBAJ

Suggested

Bandyopadhyay, A., & Bose, S. (2013). Characterization of Biomaterials. Elsevier Science. Retrieved from https://books.google.com.mx/books?id=F64aDoKssWIC

Luque, R., & Xu, C. P. (2016). Biomaterials: Biological Production of Fuels and Chemicals. De Gruyter. Retrieved from https://books.google.com.mx/books?id=COHVDAAAQBA J

Regí, M. V. (2013). Biomateriales. Los Libros de la Catarata. Retrieved from https://books.google.com.mx/books?id=IfjDngEACAAJ

Tayebi, L., & Moharamzadeh, K. (2017). Biomaterials for Oral and Dental Tissue Engineering. Elsevier Science. Retrieved from https://books.google.com.mx/books?id=j0iZDgAAQBAJ

Links:

Biomaterials: http://www.elsevier.com/wps/find/journaldescription.cws_ home/30392/description#description

Biopolymers http://www3.interscience.wiley.com/journal/28380/home? CRETRY=1&SRETRY=0

Journal of Biomedical Materials Research http://www3.interscience.wiley.com/journal/117935007/grouphome/home.html

Journal of Materials Science: Materials in Medicine http://www.springerlink.com/content/1573-4838/

Progress in Polymer Science http://www.elsevier.com/wps/find/journaldescription.cws_ home/418/description#description

	Recursos informáticos de la Biblioteca de la Universidad de Almería http://web.ual.es/web/pRecursosInformacion.jsp?id=744 Revistas internacionales sobre la materia: Advanced Drug Delivery Reviews: http://www.elsevier.com/wps/find/journaldescription.cws_home/505508/description#description

X. TEACHER PROFILE

The teacher must have a Bachelor's degree in Engineering, in Physics or related area, preferably have a Master's or Doctorate in Science or Engineering, related to the area of biomaterials; have a two-year teaching experience and / or research in the area of biomaterials; be responsible, proactive, facilitator, group mastery, effective communication skills and be a promoter of collaborative learning.