Universidad Autónoma de Nuevo León
College of Biological Sciences
Biology; Chemistry, Bacteriology and Parasitology; Food Science; Genomic Biotechnology
Analytic Program

1. Identificaton data:

Name of the learning unit:	**Physical Chemistry**
Guided time (theory and practice):	**100 hours**
Guided time per week:	**5 hours**
Total autonomous time:	**20 hours**
Modality:	**Scholarized**
Number and type of academic period:	**2° Semester**
Type of learning unit:	**Mandatory**
Cycle:	**First**
Curricular area:	**Introductory to the profession initial training (ACFI-IP)**
UANL credits:	**4**
Elaboration date:	**03/06/2021**
Responsible for elaboration:	**Dr. Ramiro Quintanilla Licea** **Dra. Claudia T. Gallardo Rivera** **Dr. Eduardo Sánchez García**
Date of last actualization:	**Does not apply**
Responsible for actualization:	**Does not apply**

2. Presentation:

In this learning unit the student will learn in a first phase to identify and analyze thermodynamic systems, as well as their interaction with the environment using laws and theoretical foundations associated with state functions. In a second phase the student will analyze the theory of chemical reactions (which includes reaction and catalysis mechanisms) based on the general characteristics of solids, liquids and gases, as well as the behavior of solutions. As a third phase the student will analyze the phenomena of mass and heat transfer applied to chemical and biological processes, the chemical equilibriums in homogeneous and heterogeneous reaction systems, as well as the occurrence of spontaneous processes considering a qualitative and quantitative description. The PIA for this course consists of the preparation of presentations in a team report on topics in which students apply the concepts of chemical thermodynamics, kinetics and balance to chemical and/or biological systems.

3. Purpose:

The purpose of the Learning Unit (UA) is that the student is able to differentiate the mechanisms of the chemical-biological processes based on the existing relationships between the different forms of energy. The physicochemical fundamentals applied to biological systems allow to understand the associated processes and develop research methods that impact on academic performance and provides the principles to develop the capacity to design, evaluate and monitor the appropriate conditions of handling, storage and processing of food.

This unit requires the basic competences acquired by the student in the UA Mathematics of the first semester, since the laws of physiochemistry also present a mathematical formulation. This unit also integrates the basic competences acquired in the UA Inorganic Chemistry of the first semester of where the student connects the basic principles that govern the atomic and molecular structure of the matter, the periodicity of the elements, the chemical bonds and the stoichiometry of the chemical reactions, as well as of the transformation of the matter to characterize and classify the matter by its physical properties , chemistry and its relationship to biological systems; background necessary for the interpretation of the nature of thermodynamic systems and the estimation of their properties. This UA contains the bases required for the following UA of the different educational programs: Microbial biodiversity (Biology) of the third semester since it will make use of the knowledge related to the molecular structure of matter as well as the properties of matter; Basic techniques in microbiology (LCA) of the third semester and Microbiology (LCA) of the fourth semester to explain how the transfer of energy occurs in the processes of conservation of food, as well as, during its handling and storage, to guarantee the quality and safety of these, as well as contributes to the UA of Unitary Operations (LCA) of the fourth semester since it requires the fundamentals of mass and energy transfer to solve balances of matter and energy, fluid dynamics and knowledge to understand the principle of operation of some unitary operations or industrial processes; Structural biochemistry (LBG) of the third semester and the Metabolic Biochemistry (LBG) of the fourth semester to explain how energy transfer occurs in biochemical processes; Analytical chemistry (QBP) since this UA requires the fundamentals of transfer and transformation of mass and energy to understand the chemical analyses that will be developed during the course.

The UA helps to the development of the general competences of the UANL by achieving that the student examines with the study of the thermodynamic system and its environment, problems related to his profession by means of the development of activities and the presentation of proposals of solution using in an adequate and efficient way specialized software (3.2.3). The student establishes a critical stance by expressing his ideas or comments on local and global facts or events (for example, global warming and the development of clean energy), showing sensitivity to the needs of others by providing clear ideas for the benefit of society (10.2.3). Identifies strengths and weaknesses of the proposed methodology for the innovative resolution of a need or challenge that the field of physical chemistry may provide (12.2.3).

It contributes to the development of the specific competencies of the Biology educational program as it learns to estimate the ecological impact by investigating the chemical, physical and biological mechanisms involved in the evolution of species and to assess the risks in the environment that affect the dynamic populations within ecosystems (E2-B).

It contributes to the development of the specific competences of the educational program of Bachelor in Food Science since it uses the theoretical, methodological and instrumental knowledge within the chemical-biological context, applying tools of the exact sciences to understand the interaction of living beings with the environment to manage the conservation of food (E1-LCA) and optimize processes involved in the transformation of food (E2-LCA).

It contributes to the development of the specific competences of the educational program of Degree in Genomic Biotechnology since it uses the theoretical, methodological and instrumental knowledge within the chemical-biological context, applying tools of the exact sciences to understand the interaction of living beings with the environment to design experimental protocols (E1-LBG), develop molecular diagnostics with the help of the concepts that govern thermodynamic systems (E2- LBG), design genome detection strategies taking into account the different forms of energy (E3-LBG) and design drugs and clinical treatments thanks to the generation and assimilation of knowledge of research methods (E4-LBG).

It contributes to the development of the specific competences of the educational program of Chemistry, Bacteriology and Parasitology since it uses theoretical, methodological and instrumental knowledge within the chemical-biological context, applying tools of the exact sciences to understand the interaction of living beings with the environment (E1-QBP) and implement methodologies to apply them to the problem in various areas of its performance where physics explains chemical processes (E2 -QBP) ensuring the quality with which they are studied (E4-QBP) to contribute to the diagnosis of diseases through physico-chemical studies (E3-QBP).

4. Competencies of the graduation profile:

General competences to which this learning unit contributes:

Instrumental competences:

3. Manage information and communication technologies as a tool for access to information and its transformation into knowledge, as well as for learning and collaborative work with cutting-edge techniques that allow its constructive participation in society.

Personal and social interaction skills

10. Intervene in the face of the challenges of contemporary society locally and globally with a critical attitude and human, academic and professional commitment to contribute to consolidating general well-being and sustainable development.

Integrative competences

12. Build innovative proposals based on a holistic understanding of reality to help overcome the challenges of the interdependent global environment.

Specific competences of the graduation profile to which the learning unit contributes.

Specific competences to which the learning unit contributes:

Biology

2. To estimate the ecological impact of ecosystems at the local, regional and national levels through the investigation of the biological mechanisms involved in the evolution of species and populations in relation to the environmental risk factors that affect the dynamic populations within ecosystems in order to ensure that conservation programs lead to their persistence as viable and self-sustaining populations in nature.

Food Science

1. Manage the conservation of food proactively, through the use of physicochemical and microbiological techniques of food analysis with a comprehensive view of its composition and the modifications that these present as a result of the handling and storage conditions to guarantee its quality and safety.

2. Optimize processes involved in food processing, by monitoring and evaluating the effect of process conditions on the physical, chemical and biological characteristics of raw materials and products, working in a multidisciplinary manner, with respect for the environment to contribute to the improvement of the productivity of companies in the food industry.

Genomic Biotechnology

1. Design experimental protocols related to biological chemistry, using theoretical, methodological and instrumental knowledge, traditional and cutting-edge, of the exact sciences, biology and chemistry, which are applied in the study of natural phenomena and biodiversity, in a logical, creative and purposeful way, in order to conserve biotic resources and the environment for the benefit of society.

2. Develop molecular diagnostics through the identification of pathogenic organisms, applying traditional and cutting-edge techniques effectively, as well as the use of innovative tools in their detection, which allow the study and treatment of genetic diseases in the health, economic and social fields.

3. Design strategies for the detection, modification and selection of genomes, through the identification of genes, proteins or cellular metabolic components, following the current regulations on biosafety of Genetically Modified Organisms (GMOs) and evaluating their competitive advantage when compared to what is traditionally used, in order to develop biotechnological products, processes and services in the health sectors , agricultural, livestock, industrial and environmental.

4. Design drugs and clinical treatments, through the selection of microorganisms with productive metabolic pathways in the market of prebiotics, probiotics and additives, as well as viral genomes of biotechnological application in the agricultural, livestock, industrial and environmental sectors that allow it to develop products and processes in the prevention of diseases.

Chemistry, Bacteriology and Parasitology

> Design experimental protocols related to biological chemistry, using theoretical, methodological and instrumental knowledge, traditional and cutting-edge, of the exact sciences, biology and chemistry, which are applied in the study of natural phenomena and biodiversity, in a logical, creative and purposeful way, in order to conserve biotic resources and the environment for the benefit of society.

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4. Design drugs and clinical treatments, through the selection of microorganisms with productive metabolic pathways in the market of prebiotics, probiotics and additives, as well as viral genomes of biotechnological application in the agricultural, livestock, industrial and environmental sectors that allow it to develop products and processes in the prevention of diseases.

2. Implement analytical methodologies in chemical-biological, microbiological and biotechnological laboratories that are applied to biomedical, agricultural, industrial and/or environmental problems, to provide results supported by the validation of the processes used, for the benefit of the health and economy of the community.

3. Contribute to the diagnosis of autoimmune, metabolic and infectious diseases through the biochemical study of the cellular response in living beings, to contribute to the treatment that guarantees an optimal state of health.

4. Develop systems of continuous improvement and quality assurance of chemical-biological, microbiological and biotechnological processes, applying current national and international regulations through compliance with the established requirements, to determine in a rigorous and objective way the properties of the products obtained, for the good of society.

5. Phase structure:

Phase 1 Fundamental concepts, First law of thermodynamics and Functions of state.
Competency element: Examine the thermodynamic system as well as the interrelationship between heat, labor, internal energy and enthalping to understand the development of chemical and biological processes

Evidence	Performance criteria	Learning activities	Content	Resources
Report of laboratory practices on the interpretation of the first law of thermodynamics.	Write report(s) on computer with correct spelling and punctuation. It should include Cover page with name of all members and group, name of the learning unit, name of the practice and date of delivery. Bibliography in APA format where it uses times new roman letter 12 line spacing 1. The structure of the practices includes the analysis of the system-environment interaction	The professor performs the framing of the UA presenting the analytical program, emphasizing the evaluation criteria, etiquette and scheduling of evidence delivery. Using Nearpod and an Infographic made on the Genially platform. The student responds to a diagnostic assessment of course expectations using the mentimeter.com platform. It also conducts review exercises on generalities of the subject, classification, units of the international	Physical and chemical properties of matter. Relationship between physics, chemistry and physico-chemistry. The nature of energy. First law of thermodynamics. enthalpy. Reaction enthalpy. calorimetry.	Teams. Board Padlet Power point Google forms OneNote (De Voe ,2020a) http://www2.chem.umd.edu/thermobook/v10-screen.pdf (De Voe ,2020b)

	through its exemplification in: 1. First law of thermodynamics (Calorimeter), 2. The analysis of a combustion reaction (Heats of combustion of alcohols). 3. Boyle's law It must comply with the following elements: Cover page, introduction, general objective, specific objective, methodology where it interprets the information provided in the videos (include flowchart), discussion (compare the results obtained in the video with the bibliographic information), conclusions and bibliography of the practice (s) carried out (s) in stage 1. Additionally, it answers a questionnaire that is part of the evaluation in each practice whose weighting is specified in the instructional guide.	system and conversion of units. The student investigates on thermodynamic system concepts and exemplifies their types with the search for representative images (open, closed, isolated). The professor asks exploratory questions about the topic investigated (thermodynamic system and its types), complements the concepts with examples and implicit assumptions using power point. The professor explains the various energy sources (potential energy, kinetic energy, internal energy, work and heat) and their relationship through an energy balance. From which the first law of thermodynamics is derived. The student analyzes videos on the calculation of heat, work, change in internal	Hess's law. Formation enthalpy Food and fuel. Characteristics of gases. The ideal gas equation. Gas mixtures and partial pressures. Kinetic-molecular theory of gases. Molecular effusion and diffusion.	http://www2.chem.umd.edu/thermobook/SolnsMan.pdf (“Determinación de calor”, 2020) https://www.youtube.com/watch?v=Rjw9u5cdCOI (Gallardo,2020) https://uanledu.sharepoint.com/sites/FSQ-AD-2020/_layouts/15/Doc.aspx?OR=teams&action=edit&sourcedoc={AD54CF17-50EE-4B77-96C1-196CFAD215C5} (“Thermodynamics”, 2020) https://thermo.pressbooks.com/ (“Procesos exotérmicos”, 2020) https://www.youtube.com/watch?v=jOAOz1WhmUQ

		energy and change in enthalpy to complement the information provided during the virtual class. The teacher will guide the student in solving type problems on the first law of thermodynamics using various systems and chemical reactions. The student reinforces his skill in solving problems on calorimetry, calculation of reaction enthalpy change (exothermic/endothermic), Hess's law and caloric content, solving interactive activities using Nearpod. The professor gives the introduction of the topic on gases and their mathematical models (Boyle's law, Charles' law and Avogadro's law) to describe their behavior (using Sway). Using the ideal gas equation as a reference. The student will participate in discussion forums organized		

		by the teacher, based on open-access videos that explain the fundamentals of Boyle's law and web consultation sources. The student investigates the molecular kinetic theory of gases in bibliographies cited in the analytical program and prepares a half-quart summary. The teacher randomly asks students to share their summary in class for feedback. The student presents individually the theoretical exam corresponding to Stage 1 through the TEAMS platform The student presents individually the practical exam of Stage 1 in the TEAMS platform where through problems analyzes a thermodynamic system and the feasibility of applying the first law		

		The student delivers the (PPA1) which consists of the delivery of report on the biological chemical processes of plant and animal cells in the context of the first law of thermodynamics.		

Phase 2. Mass and energy transport phenomena. Chemical kinetics.
Element of competence: Interpret the phase diagrams of matter and the principles of chemical kinetics to apply them to changes in chemical and biological systems.

Evidence	Performance criteria	Learning activities	Content	Resources
Report of Laboratory Practices on Phase Diagrams of Matter and Chemical Kinetics	Write report(s) on computer with correct spelling and punctuation. The student must include Cover with name of all members and group, name of the learning unit, name of the practice and date of delivery. Bibliography in APA format where it uses times new roman letter 12 line spacing 1. The structure of the practices includes the analysis of the system-environment interaction through its exemplification in:	The professor presents on surface phenomena and relative stability of solids, liquids and gases, through Power Point presentations. The student will complement the information provided by the teacher by reviewing the Video Laws of Gases. The student will review the "Water Phases diagram" infographic.	Molecular comparison of gases, liquids and solids. Intermolecular forces. Properties of liquids. Phase changes. Vapor pressure. Phase diagrams. Classification of solids. Solid structures.	classroom. laboratory. projector. Computer equipment. calculator. Analytical Program. Lesson plan.

	1. States of the matter 2. Properties of matter in solution 3. Chemical kinetics It must comply with the following elements: Cover page, introduction, general objective, specific objective, methodology where it interprets the information provided in the videos (include flowchart), discussion (compare the results obtained in the video with the bibliographic information), conclusions and bibliography of the practice (s) carried out (s) in stage 1. Additionally, it answers a questionnaire that is part of the evaluation in each practice whose weighting is specified in the instructional guide.	The students as a team solve assigned exercises to reinforce the theoretical concepts of surface phenomena and relative stability of solids, liquids and gases. The professor presents on phenomena of mass transport, energy as well as chemical kinetics, through Power Point presentations. The student will review the information from the web resource "factors affecting chemical kinetics" to complement the information provided by the teacher The team students solve cases of application of the theory of chemical reactions (which includes reaction and catalysis mechanisms) based on the general characteristics of solids, liquids and gases, as well as the behavior of solutions.	Metallic solids. Ionic solids. Molecular solids. Covalent network solids. Polymeric solids. Nanomaterials. Properties of dissolutions. Saturated solutions and solubility. Factors affecting solubility. Concentration of solutions. Collegiate properties of solutions. Chemical kinetics Factors that influence reaction rates. Reaction speeds.	Instructional Guidelines and Assessment Instruments for Phase 2 Evidence. library. Plataforma Nexus. Own Elements Water Phase Diagram Diagram of Water Phases by esagrcia2674 in Genially Open access videos Laws of Gases https://www.youtube.com/watch?v=BVES2mPBtP0 Intermolecular forces Intermolecular forces - YouTube Web query sources

		The student will participate in discussion forums organized by the teacher, based on open access videos and web consultation sources. The student individually submits the second written lab test. The student individually submits the second theoretical exam in writing. The student delivers the (PPA2) which consists of the delivery of a report on the processes involved in the development of the plant or animal cell.	Concentration and the laws of reaction rates. Change concentration over time. Temperature and speed and reaction. Reaction mechanisms. catalysis. Mass transport. Transience coefficients of pure substances. Transport of heat and mass applied to biological processes.	Factors affecting chemical kinetics Factors affecting reaction rate – KINETICS AND CHEMICAL BALANCE (utp.edu.co) General material and instruments of the physicochemistry laboratory.

Phase 3. Second and third laws of thermodynamics.

Elements of competences. Differentiate between reversible, irreversible and spontaneous processes in chemical and biological systems to establish system-environment relationships, in accordance with the second and third laws of thermodynamics.

Evidence	Performance criteria	Learning activities	Content	Resources
Report of Laboratory practices on the	Write report(s) on computer with correct spelling and punctuation.	The student responds to a prior diagnostic evaluation of	Concept of balance.	classroom.

interpretation of the second and third laws of thermodynamics.	The student must include Cover with name of all members and group, name of the learning unit, name of the practice and date of delivery. Bibliography in APA format where it uses times new roman letter 12 line spacing 1. The structure of the practices includes the analysis of the system-environment interaction through its exemplification in: 1. Chemical equilibrium 2. Second and third laws of thermodynamics 3. Entropy and Gibbs free energy It must comply with the following elements: Cover page, introduction, general objective, specific objective, methodology where it interprets the information provided in the videos (include flowchart), discussion (compare the results obtained in the video with the bibliographic information), conclusions and bibliography of	knowledge of the second and third principles of thermodynamics. Made with MS Forms. The professor exposes on the concept of chemical equilibrium, through Power Point presentations The student will supplement the information provided by the professor on the chemical balance by reviewing the web consultation source provided in the PA. The professor exposes on the second and third law of thermodynamics, through Power Point presentations The student reviews the web reference source "laws of thermodynamics" as well as the video corresponding to the topic for the student to participate in discussion forums organized by the professor.	Equilibrium constant. Interpret and work with equilibrium constants. Heterogeneous equilibrium. Calculation of equilibrium constants. Applications of equilibrium constants. Principle of LE CHÂTELIER. Spontaneous processes. Entropy and the second law of thermodynamics. Molecular interpretation of entropy. Third law of Thermodynamics. Entropy changes in chemical reactions. GIBBS free energy.	laboratory. projector. Computer equipment. calculator. Analytical Program. Lesson plan. Instructional Guides and Assessment Instruments for Phase 3 Evidence. library. Plataforma Nexus. own resources Self-Managing Evaluation Self-Managing Evaluation by Eduardo Sánchez in Genially Open access videos

	the practice (s) carried out (s) in stage 1. Additionally, the student answers a questionnaire that is part of the evaluation in each practice whose weighting is specified in the instructional guide.	The students as a team solve assigned exercises to reinforce the theoretical concepts and application of the second law of thermodynamics. Students in teams solve from assigned exercises to reinforce the theoretical concepts and application of the third law of thermodynamics. The professor explains about the calculation and implications on the quantification of entropy and Gibbs free energy, through Power Point presentations. The students as a team solve the assigned exercises to reinforce the concepts Entropy and Gibbs free energy. The student individually submits the third written lab test.	Free energy and temperature. Free energy and equilibrium constant.	Laws of thermodynamics https://www.youtube.com/watch?v=Bvfn6eUhUAc Web query sources Chemical equilibrium CHEMICAL BALANCE (mec.es) Laws of Thermodynamics Laws of Thermodynamics - Concept and characteristics Material and general instruments of the physicochemistry laboratory.

		The student individually submits the third theoretical exam in writing. The student delivers the (PPA3) which consists of the delivery of a report and presentation in Power Point on the thermodynamic analysis of the development of plant or animal cells.		

6. Assessment of learning

Phase	Evidence	PONDERACIÓN
	Diagnostic evaluation	Requisito
First Phase (25%)	Weighted activity. Laboratory exam	5
	Weighted activity. Theory exam.	10
	Evidence 1. Lab report.	6
	Weighted activity. PPA1	4
Second Phase (33%)	Weighted activity. Lab exam	5
	Weighted activity. Theory exam	15
	Evidence 2. Lab report	7
	Weighted activity. PPA2	6
Third Phase (42%)	Weighted activity. Lab exam	5
	Weighted activity. Theory exam.	20
	Evidence 3. Lab report	7
	Weighted activity. PPA3	10
	Integrative learning product	20*
	Total points	**100**

***** It is evaluated progressively during the phases (by means of the PPA), so its partial value is already found added in each phase. So, its total value would be 20 points.

7. Integrative product of the learning unit.

Research report on the energy sources of the cell, to describe the scientific bases of life that is based on bibliographical investigations of the application of the concepts of chemical thermodynamics, kinetics and balance to biological systems. See Annex 1

8. Literature.

Advances in Biological Chemistry. ABC. (2020). [online] Available at: http://www.scirp.org/journal/abc/. [Accessed 15 sep 2020]

Atkins, P., de Paula, J., and Keeler, J. (2018). Atkins´ Physical Chemistry; 11th ed.

Brown, T. L., LeMay, H. E., Bursten, B. E., and Bursten, B. E. (2018). Chemistry: the central science. Englewood Cliffs, NJ: Prentice Hall.

Capparelli, A. (2017). Tópicos de fisicoquímica. Series: Libros de Cátedra.

De voe (2020b) Solutions Manual for thermodynamics and chemistry. Recuperado de: http://www2.chem.umd.edu/thermobook/SolnsMan.pdf. Accedido el 23 de julio del 2020

De Voe, H. (2020a). Thermodynamics and chemistry. Mryland, Prentice Hall Inc. Recuperado de: http://www2.chem.umd.edu/thermobook/v10-screen.pdf Accedido el 23 de julio del 2020

Determinación de calor de combustión (2020). Recuperado de: https://www.youtube.com/watch?v=Rjw9u5cdCOI. Accedido el 23 de julio del 2020

Determinación de entalpia de disolución y reacción. (2020) Recuperado de: https://www.youtube.com/watch?v=_HUL4PkmSZE. Accedido el 23 de julio del 2020
Suzuki, T., Takemae, H. y Yoshida, M. (2013) Interpretación termodinámica de la individualidad morfológica de los cristales individuales de apatita natural y sintetizada. Revista de proceso y tecnología de cristalización, 3, 119-122.

http://dx.doi.org/10.4236/jcpt.2013.34019

Gallardo, C.T. (2020). Material didáctico sobre generalidades de sistemas termodinámicos. Recuperado de: https://uanledu.sharepoint.com/sites/FSQ-AD-2020/_layouts/15/Doc.aspx?OR=teams&action=edit&sourcedoc={AD54CF17-50EE-4B77-96C1-196CFAD215C5}

Procesos exotérmicos y endotérmicos (23 de julio del 2020). APA Style Recuperado de: https://www.youtube.com/watch?v=jOAOz1WhmUQ

Thermodynamics (21 de julio 2020) APPA style. Recuperado de: https://thermo.pressbooks.com/

Anexo 1. Instructional guide PIA

Integrative product of learning: Report on bibliographical investigations of the application of the concepts of thermodynamics, kinetics and chemical balance to biological systems.

Instructions:	The PIA consists of the preparation of partial reports in each phase of a bibliographical research on the energy sources of the cell, in order to understand the scientific bases of life. Additionally, it will make the relevant reports of the progress of the research that will be evaluated in each phase of the course.
Valor:	20 %
Evaluation criteria	**First partial (PPA1):** Title appropriate to the Phase. The introduction should include generalities of cellular functioning and its interaction with the environment, typical reactions associated with its growth (identification of endothermic and exothermic reactions, as well as multiphases reactions). Methodology: Develop a flowchart (blocks) that concisely shows the most relevant aspects investigated in the generalities. Indicate in the diagram the study system, its classification (open, closed, isolated system),

energy generating source (nature of energy), variables involved in the system-environment interaction (gas generation, excretion of liquids etc.), emphasizing at what point in the biological process is the transformation of energy, thus fulfilling the First Principle.
Discussion: Rationale for the choice of phases for thermodynamic analysis. According to the actual situation and determine if the first law of thermodynamics is met and suggest at least 2 assumptions for this to occur.
Make conclusions.

Second partial (PPA2):
Report on the processes involved in the development of the plant or animal cell.
Title appropriate to the Phase.
La presentación debe incluir la información relevante corregida del PPA1.
The introduction incorporates specific specifications of the reactions related to cell growth, production of metabolites associated and not associated with their growth (physical characteristics: solid, gel, liquid, gas). Include processes where phase changes occur and exemplify key reactions in cell development, the types of catalysts involved, and the processes where mass transfer occurs (may include phase change, osmotic and/or thermal processes).
Methodology: Develop a flowchart (blocks) that incorporates the relevant aspects of cell development cited above. Include the description of the function of each built-in phase and it should be mentioned that part of the system is affected by the changes proposed in the report
Discussion: Based on the diagram, I complemented the conclusion of PPA1 and based on the choice of the phases where the thermodynamic analysis was performed. Make conclusions.

Third part (PPA3):
Report on the thermodynamic analysis of the development of plant or animal cells.
Title appropriate to the Phase.
The report should include the corrected relevant information of PPA1 and PPA2, requesting that of the works (PPA1 and PPA2) determining the association of the first principle and the second principle in chemical kinetics.
Incorporate in Introduction information about the reactions that reach equilibrium during the development of the cell. Identification of the spontaneity of the processes and quantitative determination of these by calculating Gibbs free energy exchange.

	Methodology: Include in the flowchart d PPA1 and PPA2 the section corresponding to thermodynamic analysis from the point of view of equilibrium, qualitative and quantitative analysis of the spontaneity of the processes associated with cell development. To carry out a discussion directed towards the main assumptions that support the exemplification that allowed the development of the thermodynamic analysis of the system (cell).
Mode:	Team