AP BIOLOGY

Biochemistry

Essential Questions

What is the role of energy in the making and breaking of polymers?

How do living systems transmit information in order to ensure their survival?

How would living systems function without the polarity of the water molecule?

Understandings

*Students will understand that:*

Organisms must exchange matter with the environment to grow, reproduce, and maintain organization.

Atoms and molecules from the environment are necessary to build new molecules— carbon, nitrogen.

Hydrolysis and dehydration synthesis are used to cleave and form covalent bonds between monomers.

Structure and function of polymers is derived from the way their monomers are assembled— nucleic acids, proteins, carbohydrates, lipids.

Enzymes are biological catalysts that help chemical reactions and are affected by environmental conditions.

Organisms use feedback mechanisms to maintain their internal environments and respond to internal and external environmental changes.

Knowledge:

*Students will know:*

The parts of biological molecules and their sequence determine the properties of that molecule.

Living systems depend on properties of water that result from its polarity and hydrogen bonding.

The hydrogen bonds between water molecules result in cohesion, adhesion, and surface tension.

Carbon is used to build the 4 essential biological molecules (carbohydrates, proteins, lipids, and nucleic acids). Nitrogen is essential for the formation of nucleic acids and proteins. Phosphorus is needed for nucleic acids and phospholipids.

How hydrolysis and dehydration synthesis are used to build or break polymers.

Complex carbohydrates are made of simple sugars that determine the structure and function of the complex carbohydrate.

Lipids are nonpolar molecules and come in multiple forms. Lipids can be saturated or unsaturated, affecting their function. Phospholipids have polar and nonpolar sections that control their function in membranes.

Directionality of the subcomponents influences structure and function of the polymer – Nucleic acids and Proteins.

DNA structure is an antiparallel double helix with following Chargaff’s base pairing rules.

DNA and RNA molecules have structural similarities and differences related to their function.

Information for organisms is encoded in the sequence of nucleotides. Nucleotides are made of a 5-carbon sugar, nitrogen base and a phosphate group.

The specific order of amino acids in a protein determines its structure and therefore it’s function. The structure is affected by the proximity of R groups and their chemical structure. Proteins have four levels of organization, determined by their structure and controlling their function.

The structure of enzymes includes the active site that specifically interacts with substrate molecules.

For an enzyme-mediated chemical reaction to occur, the shape and charge of the substrate must be compatible with the active site of the enzyme.

The structure and function of enzymes contribute to the regulation of biological processes. Enzymes are biological catalysts that facilitate chemical reactions in cells by lowering the activation energy.

Change to the molecular structure of a component in an enzymatic system may result in a change of the function or efficiency of the system— denaturation of protein structure, environmental temperatures, pH

Environmental pH can alter the efficiency of enzyme activity, including through disruption of hydrogen bonds that provide enzyme structure.

The relative concentrations of substrates and products determine how efficiently an enzymatic reaction proceeds.

Higher environmental temperatures increase the speed of movement of molecules in a solution, increasing the frequency of collisions between enzymes and substrates and therefore increasing the rate of reaction.

Competitive inhibitor molecules can bind reversibly or irreversibly to the active site of the enzyme. Noncompetitive inhibitors can bind allosteric sites, changing the activity of the enzyme.

Feedback mechanisms maintain homeostasis for a particular condition by regulating physiological processes. If a system is perturbed, negative feedback mechanisms return the system back to its target set point. These processes operate at the molecular and cellular levels. Positive feedback mechanisms amplify responses and processes in biological organisms. The variable initiating the response is moved farther away from the initial set point. Amplification occurs when the stimulus is further activated, which, in turn, initiates an additional response that produces system change.

Skills:

*Students will be able to:*

Describe and explain the biological concepts associated both in words and visuals.

Use data to support a claim and justify this support with appropriate biological concepts.

Predict effects of changes to the system with visual representations.

Calculate sample means, standard deviation, and standard error of the mean.

Create a graph with appropriate statistics to show significance.

Identify experimental procedures aligned to answering the question, including appropriate controls

Identify patterns among the different biological molecules.

Curriculum Standards - 2019 College Board Course & Exam Description

Explain how the properties of water that result from its polarity and hydrogen bonding affect its biological function.

Describe the composition of macromolecules required by living organisms.

Describe the properties of the monomers and the type of bonds that connect the monomers in biological macromolecules.

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Explain how a change in the subunits of a polymer may lead to changes in structure or function of the macromolecule.

Describe the structural similarities and differences between DNA and RNA.

Describe the properties of enzymes.

Explain how enzymes affect the rate of biological reactions.

Explain how changes to the structure of an enzyme may affect its function.

Explain how the cellular environment affects enzyme activity.

Describe positive and/ or negative feedback mechanisms.

Explain how negative feedback helps to maintain homeostasis.

Explain how positive feedback affects homeostasis.

Performance Task or Design Thinking Culminating Assessment

Yeast Sphere Inquiry lab – Students will do a guided inquiry lab to determine the effect of a chosen variable upon enzyme function. Students will produce a Google Slides presentation of their experiment, including Claim, Evidence Reasoning analysis of data.

Other Evidence (formative assessments, summative assessments)

Mastering Biology

Unit test of AP questions

Activities listed in learning plan

Diabetic Ketoacidosis Case Study

Concept mapping

Topic Overview

*Order of topics presented (Calendar)*

Chemistry Review by students independently

Water & pH

Carbohydrates

Lipids

Proteins

Nucleic Acids

Enzyme structure and function with feedback control

Learning Plan

*Learning Activities - What experiential or inductive learning will help students to explore the big ideas and questions to achieve desired understandings? for their expected performances?*

Penny lab with statistics

pH and buffer lab

Pattern matching activity

Enzyme stop motion activity

Working like an enzyme activity

Yeast Sphere Catalase enzyme lab

Diabetic Ketoacidosis Case Study

Resources

Biology in Focus 2nd edition

Mastering Biology

Penny lab with statistics – pennies, water, soap, directions, analysis

pH and buffer lab – test tubes, milk, water, potato suspension, salt water, indicator, acid (vinegar, HCl), parafilm, pH paper, commercial antacids, mortar/pestle, droppers, spin bar, spinner, large poster paper, directions

Pattern matching activity – pattern matching cards (find online if needed), directions

Enzyme stop motion video – playdoh, markers for lab bench, student device with stop motion app or iMovie

Working like an enzyme – directions, cutouts, pencil

Yeast sphere catalase enzyme lab – directions, hydrogen peroxide, beakers, yeast spheres (find directions online to make), timer, variables options (pH, temperature, substrate), Google Slides