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Did I forget something? Know of a mistake? Have a suggestion? Broken link?
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UNIT 32: Enzymes and Metabolism

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IB topic(s): 2.1, 2.5 and 8.1
Essential Idea(s): Living Organisms control their composition by complex web of chemical reactions. Metabolic reactions are regulated in response to the cell's needs. Enzymes control the metabolism of the cell.
Unit Length: 8 days

Pre-assessment: Initial knowledge audit				
Lesson	**Topic**	**Days**	**Statement(s) and Objective(s)**	**Activities** (updated 18 May 2018)
1	Metabolism	1	2.1.U4: Metabolism is the web of all the enzyme-catalyzed reactions in a cell or organism (Oxford Biology Course Companion page 67). ● Define metabolism and catalysis. ● State the role of enzymes in metabolism. 8.1.U1: Metabolic pathways consist of chains and cycles of enzyme-catalyzed reactions (Oxford Biology Course Companion page 374). ● Contrast metabolic chain reaction pathways with cyclical reaction pathways.	Unit note packet Metabolism notes Scitable metabolism reading

2	Enzyme Structure	1	2.5.U1: Enzymes have an active site to which specific substrates bind (Oxford Biology Course Companion page 96). ● State the relationship between enzyme substrate and enzyme active site. ● Explain the relationship between enzyme structure and enzyme specificity, including the role of the active site.	Structure notes presentation Structure notes handwritten Structure review
3	Enzyme Function	1	2.5.U2: Enzyme catalysis involves molecular motion and the collision of substrates with the active site (Oxford Biology Course Companion page 97). ● Outline the three stages of enzyme activity. ● Explain the role of random collisions in the binding of the substrate with the enzyme active site. ● Describe the induced fit model of enzyme action. 8.1.U2: Enzymes lower the activation energy of the chemical reactions that they catalyse (Oxford Biology Course Companion page 374). ● Define activation energy. ● Explain the role of enzymes in lowering the activation energy of a reaction. 8.1.S2: Calculating and plotting rates of reaction from raw experimental results (Oxford Biology Course Companion page 378). ● State two methods for determining the rate of enzyme controlled reactions.	Enzyme catalysis notes Steps of enzyme catalysis hand-written Enzyme function animation Play Doh enzymes Reading: Enzymes exposed Enzyme DBQ Enzyme assay simulation **Enzyme function role plays:** Paper folding, punching and cutting Pop beads Toothpickase Cookie ases (NABT) Lego enzymes

			• State the unit for enzyme reaction rate. • Given data, calculate and graph the rate of an enzyme catalyzed reaction.	
4	Enzyme Regulation	1	2.5.U3: Temperature, pH,and substrate concentration affect the rate of activity of enzymes (Oxford Biology Course Companion page 98). • Explain how temperature affects the rate of enzyme activity. • Draw a graph of depicting the effect of temperature on the rate of enzyme activity. • Explain how pH affects the rate of enzyme activity. • Draw a graph of depicting the effect of pH on the rate of enzyme activity. • Identify the optimum temperature or pH for enzyme activity on a graph. • Explain how substrate concentration affects the rate of enzyme activity. • Draw a graph of depicting the effect of substrate concentration on the rate of enzyme activity. 2.4.A2: Denaturation of proteins by heat or by deviation of pH from the optimum (Oxford Biology Course Companion page 92). • Define denaturation. • Outline the effect of heat and pH on protein structure.	Environmental effects on enzyme function Environmental effects hand-written NABT: Siamese Cat Color A&B: Heat Beaters reading

			2.5.U4: Enzymes are denatured (Oxford Biology Course Companion page 100). ● State the effect of denaturation on enzyme structure and function.	
5	Enzyme Inhibition	1	8.1.U3: Enzyme inhibitors can be competitive or noncompetitive (Oxford Biology Course Companion page 375). ● Define enzyme inhibitor. ● Contrast competitive and noncompetitive enzyme inhibition. ● Outline one example of a competitive enzyme inhibitor and one example of a noncompetitive enzyme inhibitor. 8.1.U4: Metabolic pathways can be controlled by end-product inhibition (Oxford Biology Course Companion page 377). ● Describe allosteric regulation of enzyme activity. ● Outline the mechanism and benefit of end-product inhibition. 8.1.A1: End-product inhibition of the pathway that converts threonine is isoleucine (Oxford Biology Course Companion page 377). ● Illustrate end-product inhibition of the threonine to isoleucine metabolic pathway. ● State the consequence of an increase in isoleucine concentration.	Regulation of metabolism notes Pop-bead inhibition

			8.1.S1: Distinguish different types of inhibition from graphs at specified substrate concentration (Oxford Biology Course Companion page 376). ● Explain why the rate of reaction with increasing substrate concentration is lower with a non-competitive inhibitor compared to a competitive inhibitor. 8.1.NOS: Developments in scientific research follow improvements in computing- developments in bioinformatics, such as the interrogation of databases have facilitated research into metabolic pathways (Oxford Biology Course Companion page 377). ● Outline the use and benefits of the bioinformatics technique of chemogenomics in development of new pharmaceutical drugs. 8.1.A2: Use of databases to identify potential new anti-malarial drugs (Oxford Biology Course Companion page 378). ● Outline the reasons for development of new anti-malarial drugs. ● Explain the use of databases in identification of potential new anti-malarial drugs.	
6	Enzyme Experiment	2	2.5.S1: Design of experiments to test the effect of temperature, pH, and substrate concentration on the activity of enzymes (Oxford Biology Course Companion page 101).	Intro to enzyme experiments Measuring enzyme reaction notes Intro to enzyme inquiry (former IA)

			• Identify and manipulated, responding and controlled variables in descriptions of experiments testing the activity of enzymes. 2.5.S2: Experimental investigation of a factor affecting enzyme activity (Practical 3) (Oxford Biology Course Companion page 102). • Describe three techniques for measuring the activity of an example enzyme. 2.5.NOS: Experimental design-accurate, quantitative measurements in enzyme experiments require replicates to ensure reliability (Oxford Biology Course Companion page 100). • Define quantitative and qualitative. • Determine measurement uncertainty of a measurement tool. • Explain the need for repeated measurements (multiple trials) in experimental design. • Explain the need to controlled variables in experimental design.	Simple enzyme experiments (Miller) Catalase lab information Pectinase lab information Gelatin digestion Bromelain lab information Amylase lab information
7	Industrial Applications	1	2.5.U5: Immobilized enzymes are widely used in industry (Oxford Biology Course Companion page 103). • List industries that use commercially useful enzymes. • Explain how and why industrial enzymes are often immobilized.	Enzymes in Industry notes Enzyme in industrial reading Lactase lab (K. Foglia) Cellulase lab

			2.5.A1: Methods of production of lactose-free milk and its advantages (Oxford Biology Course Companion page 105). ● State the source of the lactase enzyme used in food processing. ● State the reaction catalyzed by lactase. ● Outline four reasons for using lactase in food processing.	https://www.ted.com/talks/adam_garske_how_designing_brand_new_enzymes_could_change_the_world
Post Assessment: final knowledge audit				

1 page summary prompts:

- Define: metabolism, catalysis, enzyme, substrate, active site, anabolic, catabolic, “specific,” activation energy, induced fit, optimum, denaturation, inhibitor, allosteric inhibitor, end product inhibition, immobilized enzyme
- Compare chain and cyclical reactions
- Outline the three stages of enzyme activity
- Explain graphs of: enzyme activation energy, enzyme rates and temp, pH, [substate], [enzyme], competitive inhibition, non-competitive inhibition
- Compare competitive and noncompetitive inhibition (with example of each)
- List industries that use enzymes
- Outline production of lactose-free milk using lactase (how and why?)