IB Biology HL

Optional Summer Enrichment

2024

Instructions

Each page contains one topic from the **Standard Level (SL) curriculum** for IB Biology. Most of these topics are generally taught at some level in the 9th grade Biology courses. The pages are organized in the order in which I will teach the course over the next two years. Your objective throughout this optional activity is to answer the questions on each page as accurately and completely as possible, knowing that you might not remember details from your previous Biology class, or might not have ever learned it before! However, you are encouraged to use resources to help you. Some *suggested* resources include:

- Bozeman Science YouTube Playlist
- Alex Lee YouTube Channel
- Crash Course YouTube Playlist
- Khan Academy

Unit 1: Ecology

Topic C4.1 – Populations and Communities

What is a population? A community?

How do populations grow? What is a carrying capacity?

How do organisms cooperate and compete within communities?

How do predator and prey populations interact?

Topic B4.2 – Ecological Niches

What is an ecological niche?

What is an autotroph? A heterotroph?

What are producers? Consumers? Decomposers?

What are the types of consumers?

Topic C4.2 – Transfers of Energy and Matter

What is the main source of energy for ecosystems?

What is a food chain? A food web?

How do autotrophs use solar energy? How do heterotrophs obtain energy?

What is the difference between photosynthesis and cellular respiration?

What are energy pyramids?

How does carbon cycle through an ecosystem?

Topic B4.1 – Adaptation to Environment

What is a habitat?

What are adaptations?

How do limiting factors affect populations?

What is a biome? What are the main biomes of the world?

Topic D4.2 – Stability and Change

What makes an ecosystem stable?

What is a keystone species?

What is sustainable agriculture?

What is eutrophication?

What is biomagnification?

How can ecosystems be restored?

Topic D4.3 – Climate Change

What are the human causes to climate change?

What is global warming?

How are polar habitats changing due to global warming?

How are ocean currents changing due to climate change?

How are coral reefs affected by climate change?

Unit 2: Biodiversity

Topic A3.1 – Diversity of Organisms

What is variation among organisms?

What is a species? How are species given scientific names?

How do chromosome numbers differ among species?

What is karyotyping?

What is a genome? Why do scientists sequence genomes?

Topic A4.2 – Conservation of Biodiversity

What is biodiversity?

How have humans contributed to extinction of species?

What are some causes of ecosystem loss?

What is the biodiversity crisis? What is the evidence of the crisis? What are the causes of the current crisis?

Why is conservation of biodiversity important?

Why are endangered species put on lists and how do scientists determine which species to add to the list?

Unit 3: Evolution

Topic A4.1 – Evolution and Speciation

What is evolution?

How does DNA, RNA, or amino acid sequencing provide evidence for evolution?

How does selective breeding of domesticated animals and crop plants provide evidence for evolution?

How do homologous structures provide evidence for evolution?

What is convergent evolution? What are analogous structures?

What is speciation?

What is reproductive isolation and how does it lead to speciation?

Topic D4.1 – Natural Selection

What is natural selection?

How does mutation and sexual reproduction lead to variation of species?

How does overproduction of offspring and competition for resources lead to natural selection?

How do adaptations contribute to survival of the fittest?

What is sexual selection?

Unit 4: Biochemistry

Topic A1.1 – Water

Why is water the medium for life?

How do hydrogen bonds form within water?

What is cohesion? Adhesion?

What are the solvent properties of water?

What are the physical properties of water?

Topic B1.1 – Carbohydrates and Lipids

What are the chemical properties of a carbon atom?

How are polymers made via condensation reactions?

How are polymers digested via hydrolysis reactions?

What is the structure and function of monosaccharides? Polysaccharides?

What are the hydrophobic properties of lipids?

What are the differences between saturated and unsaturated fatty acids?

What are triglycerides?

How do phospholipids form bilayers?

Topic B1.2 – Proteins

What is an amino acid? What is its structure?

What are the dietary requirements for amino acids?

Why can infinite varieties of polypeptides form?

How does pH and temperature affect protein structure?

Topic C1.1 – Enzymes

Why are enzymes catalysts? How do enzymes affect activation energy?

How do enzymes aid metabolism?

What are anabolic and catabolic reactions?

What is the significance of an enzyme's active site?

How does molecular motion of substrates lead to enzyme catalysis?

What is the difference between the lock-and-key model and the induced-fit model of enzyme catalysis?

How do temperature, pH, and substrate concentration affect enzyme activity?

How are enzymes denatured?

Unit 5: Cells

Topic A2.2 – Cell Structure

What are cells?

What is a microscope and how is it used? How were microscopes developed?

What structures are common to all cells?

What are prokaryotic cells? Eukaryotic cells?

What are the processes of life and how can they occur within unicellular organisms?

What are the differences between fungal, plant, and animal cells?

Topic B2.2 – Organelles and Compartmentalization

What are organelles?

Why is the nucleus separated from the cytoplasm?

Why is there compartmentalization in the cytoplasm?

Topic B2.3 – Cell Specialization

What are unspecialized versus specialized cells?

What is differentiation?

What are stem cells? What are the main types of stem cell?

Where are stem cell niches found in adult humans? What is their role?

Why are different specialized cells different in size?

How does the surface area-to-volume ratio limit cell size?

Unit 6: Cell Membranes

Topic B2.1 – Membranes and Membrane Transport

Why do lipid bilayers form cell membranes? How do they act as barriers?

What are integral and peripheral membrane proteins? What are aquaporins? What are channel proteins? What are pump proteins?

What is simple diffusion? What is facilitated diffusion?

What is selective permeability?

What are glycoproteins and glycolipids?

What is the fluid mosaic model?

Topic D2.3 – Water Potential

How does water act as a solvent?

What is osmosis?

What is the difference between hypertonic, hypotonic, and isotonic solutions?

What is the effect of osmosis on cells without cell walls (AKA an animal cell)?

What is the effect of osmosis on cells with cell walls (AKA a plant cell)?

Topic B3.2 – Transport

What is the difference between arteries, veins and capillaries with respect to structure?

What is the pulse and how is it measured?

What are valves in veins?

What are the coronary arteries and what happens if they develop blockages?

What is transpiration?

What is xylem?

Topic C3.2 – Defense against Disease

What are pathogens?

How does the skin and the mucous membranes act as the first line of defense against pathogens?

How does blood clotting seal wounds in the skin or to blood vessels?

What is the difference between the innate and the adaptive immune system?

What are phagocytes and how do they perform phagocytosis?

What are lymphocytes? How do they produce antibodies?

What are antigens?

What is the difference between a B-cell and a T-cell?

Unit 7: Reproduction

Topic D2.1 – Cell and Nuclear Division

What is cell division? What is cytokinesis?

What is mitosis? Meiosis?

Why does DNA replication occur before cell division?

How do chromosomes condense and move during cell division?

What are the phases of mitosis?

Why is meiosis a reduction division?

What is non-disjunction and how can it lead to Down syndrome?

How does meiosis contribute to variation within a species?

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Unit 8: Homeostasis

Topic D3.3 – Homeostasis

What is homeostasis?

What are negative feedback loops and how do they contribute to homeostasis?

How is blood glucose regulated?

What is the difference between type 1 and type 2 diabetes?

How is body temperature regulated?

Topic C2.2 – Neural Signalling

What are neurons?

What are nerve impulses (action potentials)?

How do nerve impulses travel down a neuron?

How do nerve impulses cross a synapse?

What are neurotransmitters?

Topic C3.1 – Integration of Body Systems

How are cells, tissues, organs, and body systems related?

How does hormonal and nervous signalling integrate body systems within animals?

Why is the brain the central information center? How does the spinal cord act as a central integration center?

What is the difference between sensory and motor neurons?

What is a pain reflex arc?

What is the role of the cerebellum?

How does melatonin modulate sleep patterns?

How does epinephrine (adrenaline) act for the fight-or-flight response?

What is the endocrine system? How is it controlled by the hypothalamus and pituitary gland?

How is heart rate controlled? Ventilation rate? Peristalsis within the digestive system?

Unit 9: DNA

Topic A1.2 – Nucleic Acids

What is DNA?

What is a nucleotide? What is its structure?

What is the sugar-phosphate backbone of DNA and RNA?

What is the role of the nitrogenous bases in nucleic acids?

How is RNA formed by condensation?

How is DNA formed as a double helix? What are antiparallel strands?

What are the similarities and differences between DNA and RNA?

What is complementary base pairing?

Why does DNA have a limitless capacity to store genetic information?

How does the universal genetic code provide evidence for common ancestry?

Topic D1.1 – DNA Replication

How does DNA replication allow for the production of exact copies of DNA?

Why is DNA replication semi-conservative?

How do the following enzymes work to replicate DNA: Helicase and DNA polymerase?

How does the polymerase chain reaction (PCR) work? Gel electrophoresis?

Topic D1.2 – Protein Synthesis

What is the process of transcription?

What is the process of translation?

What are the roles of mRNA, ribosomes, and tRNA in translation?

How is the the codon chart used to determine which amino acid is coded for by each codon?

How does the ribosome build a polypeptide chain?

What are mutations? How do they influence protein structure?

Topic D1.3 – Mutation and Gene Editing

What are gene mutations?

What are consequences of point (substitution) mutations?

What are the consequences of frameshift (insertion or deletion) mutations?

What are causes of mutations? How are mutations random?

What are the consequences of mutations occurring in germ cells versus somatic cells?

How does mutation increase genetic variation of a species?

Unit 10: Energy

Topic C1.3 – Photosynthesis

What is photosynthesis?

What is photolysis?

How are photosynthetic pigments separated by chromatography?

How do photosynthetic pigments absorb specific wavelengths of light?

How do temperature, light intensity, and carbon dioxide concentration affect rates of photosynthesis? How could an experiment be designed to test these factors?

Topic C1.2 – Cell Respiration

What is ATP? How is ATP used by cells? What is the ATP-ADP cycle?

What is cell respiration?

Compare and contrast aerobic cell respiration and anaerobic cell respiration with respect to the need for oxygen and ATP yield.

What variables can impact the rate of cellular respiration?

Topic B3.1 – Gas Exchange

Why is gas exchange a vital function of all organisms?

What are the properties of surfaces where gas exchange occurs?

How are mammalian lungs adapted for gas exchange?

How does ventilation of the lungs occur?

How can lung volumes be measured?

How are various types of plant leaves adapted for gas exchange?

How are tissues distributed in leaves?

What is transpiration? How can a potometer be used to measure rate of transpiration?

What are stomata and how do they contribute to transpiration?