# FREEHOLD REGIONAL HIGH SCHOOL DISTRICT
## OFFICE OF CURRICULUM AND INSTRUCTION
## INTERNATIONAL BACCALAUREATE PROGRAM

# IB BIOLOGY SL & HL, YEAR 2

Grade Level: 12

Credits: 5

**BOARD OF EDUCATION ADOPTION DATE: August 24, 2023**

# FREEHOLD REGIONAL HIGH SCHOOL DISTRICT

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**IB Biology SL & HL, Year 2**

**Course Description**

From the 2023 International Baccalaureate Biology Subject Guide: “The study of life makes progress through not only advances in techniques, but also pattern recognition, controlled experiments and collaboration between scientists. Unifying themes provide frameworks for interpretation and help us make sense of the living world: Form and function, Unity and diversity, Continuity and change, and Interaction and interdependence are four of the themes around which this biology syllabus is constructed, although other frameworks are possible.

The scale of life in biology ranges from the molecules and cells of organisms to ecosystems and the biosphere. This way of considering complex systems as simpler components—an approach known as reductionism—makes systems more manageable to study. It is the foundation of controlled experiments and has thus enabled major discoveries, but it provides an incomplete view of life. At each level of biological organization, different properties exist. Living systems are based on interactions, interdependence and integration of components between all levels of biological organization. A student of biology should gain not only a conceptual understanding of the subject, but also an awareness of how biologists construct knowledge claims and the limitations of these methods.

Students at SL and HL share the following: an understanding of science through a stimulating experimental programme; the nature of science as an overarching theme; the study of a concept-based syllabus; one piece of internally assessed work, the scientific investigation; the collaborative sciences project. The SL course provides students with a fundamental understanding of biology and experience of the associated skills. The HL course requires students to increase their knowledge and understanding of the subject, and so provides a solid foundation for further study at university level.”

**Course Sequence and Pacing**

| **Unit Title** | **Section Focus** | **Suggested Pacing** |
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| Unit 9: Ecology | Section 9.1: Adaptation to Environment<br>Section 9.2: Transfers of Energy and Matter<br>Section 9.3: Populations and Communities<br>Section 9.4: Ecological Niches | 19 sessions |
| Unit 10: Ecological Stability | Section 10.1: Stability and Change<br>Section 10.2: Conservation of Biodiversity<br>Section 10.3: Climate Change<br>Section 10.4: Internal Assessment | 15 sessions |
| Unit 11: Homeostasis and Cell Communication | Section 11.1: Homeostasis<br>Section 11.2: Chemical Signalling<br>Section 11.3: Internal Assessment<br>Section 11.4: Neural Signalling | 16 sessions |
| Unit 12: Integration of Body Systems | Section 12.1: Integration of Body Systems<br>Section 12.2: Muscle and Motility | 10 sessions |
| Unit 13: Immune System and Pathogens | Section 13.1: Defence Versus Disease<br>Section 13.2: Viruses | 7 sessions |
| Unit 14: Respiratory System | Section 14.1: Transport<br>Section 14.2: Gas Exchange | 6 sessions |
| Unit 15: Reproductive System and Cell Specialization | Section 15.1: Reproduction<br>Section 15.2: Cell Specialization | 11 sessions |

| **Support Resources** |
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| Supporting resources and appendices for this curriculum are available. These include a Resource Catalog of standards-aligned activities, common formative assessment and interdisciplinary items for performance expectations and objectives in this course.<br>● IB Biology SL & HL Resource Catalog<br>● Appendix A: Accommodations and Modifications for Various Student Populations<br>● Appendix B: Assessment Evidence<br>● Appendix C: Interdisciplinary Connections |

| **IB Biology SL & HL, Year 2** **Suggested Pacing: 3 sessions**<br>**Unit 9: Ecology**<br>**Section 9.1: Adaptation to Environment** |
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| **IB Guiding Questions** |
| B4.1.a How are the adaptations and habitats of species related?<br>B4.1.b What causes the similarities between ecosystems within a terrestrial biome? |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: |
| 9.1 [1] **Define** a habitat as the place in which a community, species, population or organism lives<br>*A. Give the precise meaning of a word, phrase, concept or physical quantity.* |
| 9.1 [2] **Outline** the adaptations of organisms to the abiotic environment of their habitat (i.e. a grass species adapted to sand dunes and a tree species adapted to mangrove swamps.<br>*A. Give a brief account or summary.* |
| 9.1 [3] **List** abiotic variables that affect species distribution (e.g. include abiotic factors for both plants and animals)<br>*A. Give a sequence of brief answers with no explanation.* |
| 9.1 [4] **analyze** transect data and **determine** the range of tolerance of a limiting factor of a seminatural habitat (e.g. temperature, light intensity, soil pH)<br>*A. Break down in order to bring out the essential elements or structure.*<br>*B. Obtain the only possible answer.* |
| 9.1 [5] **Describe** the conditions required for coral reef formation (e.g. water depth, pH, salinity, clarity and temperature)<br>*A. Give a detailed account.* |
| 9.1 [6] **Construct** a graph to illustrate how abiotic factors are determinants of terrestrial biome distribution (i.e. temperature and rainfall)<br>*A. Display information in a diagrammatic or logical form.* |
| 9.1 [7] **Describe** biomes as groups of ecosystems with similar communities due to similar abiotic conditions and convergent evolution<br>*A. Give a detailed account.* |
| 9.1 [8] **List** adaptations to life in hot deserts and tropical rainforest (i.e. provide examples of adaptations in named species of plants and animals)<br>*A. Give a sequence of brief answers with no explanation.* |

**IB Biology SL & HL, Year 2** **Suggested Pacing: 5 sessions**
**Unit 9: Ecology**
**Section 9.2: Transfers of Energy and Matter**

**IB Guiding Questions**

C4.2.a What is the reason matter can be recycled in ecosystems but energy cannot?
C4.2.b How is the energy that is lost by each group of organisms in an ecosystem replaced?

**Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives:

9.2 [1] **Define** ecosystems as open systems in which both energy and matter can enter and exit and **contrast** ecosystems with closed systems (i.e. only energy is able to pass in and out in a closed system)
*A. Give the precise meaning of a word, phrase, concept or physical quantity.*

9.2 [2] **Identify** sunlight as the principal source of energy that sustains most ecosystems (i.e. examples of exceptions include ecosystems in caves and below the levels of light penetration in oceans), recognizing (NOS) that laws in science are formulated to describe patterns observed in nature
*A. Provide an answer from a number of possibilities.*

9.2 [3] **Describe** the flow of chemical energy through food chains
*A. Give a detailed account.*

9.2 [4] **Construc**t food chains and food webs to represent feeding relationships in a community using arrows to indicate the direction of energy flow and biomass
*A. Display information in a diagrammatic or logical form.*

9.2 [5] **Describe** how energy is supplied to decomposers from carbon compounds in organic matter coming from dead organisms (e.g. faeces, dead parts of organisms and dead whole organisms)
*A. Give a detailed account.*

9.2 [6] **Define** autotrophs as organisms that use external energy sources to synthesize carbon compounds from simple inorganic substances (i.e. for carbon fixation and for the anabolic reactions that build macromolecules)
*A. Give the precise meaning of a word, phrase, concept or physical quantity.*

9.2 [7] **Contrast** the use of light as the external energy source in photoautotrophs and oxidation reactions as the energy source in chemoautotrophs (e.g. iron-oxidizing bacteria as an example of a chemoautotroph)
*A. Give an account of si differences between two (or more) items or situations, referring to both (all) of them throughout.*

9.2 [8] **Describe** heterotrophs as organisms that use carbon compounds obtained from other organisms to synthesize the carbon compounds that they require
*A. Give a detailed account.*

9.2 [9] **Outline** the release of energy in both autotrophs and heterotrophs by oxidation of carbon compounds in cell respiration
*A. Give a brief account or summary.*

9.2 [10] **Describe** the classification of organisms into trophic levels (i.e. use the terms “producer”, “primary consumer”, “secondary consumer” and “tertiary consumer”)
*A. Give a detailed account.*

9.2 [11] **Construct** energy pyramids using research data from specific ecosystems
*A. Display information in a diagrammatic or logical form.*

9.2 [12] **Describe** the reductions in energy availability at each successive stage in food chains due to large energy losses between trophic level
*A. Give a detailed account.*

9.2 [13] **Estimate** the efficiency of cell respiration in both autotrophs and heterotrophs (i.e. energy transfers are not 100% as heat is lost when ATP is produced in cell respiration and used in cells)
*A. Obtain an approximate value.*

9.2 [14] **Explain** how energy losses reduce the number of trophic levels in ecosystems (i.e. there is less biomass but the energy content per unit mass is not reduced)
*A. Give a detailed account including reasons or causes.*

9.2 [15] **Define** primary production as the accumulation of carbon compounds in biomass by autotrophs (i.e. units should be mass (of carbon) per unit area per unit time)
*A. Give the precise meaning of a word, phrase, concept or physical quantity.*

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| 9.2 [16] **Define** secondary production as the accumulation of carbon compounds in biomass by heterotrophs and **contrast** primary production with secondary production (i.e. due to loss of biomass when carbon compounds are converted to carbon dioxide and water in cell respiration, secondary production is lower than primary production in an ecosystem)<br>*A. Give the precise meaning of a word, phrase, concept or physical quantity.*<br>*B. Give an account of differences between two (or more) items or situations, referring to both (all) of them throughout.* |
| 9.2 [17] **Construct** carbon cycle diagrams and **annotate** to show how carbon is recycled by photosynthesis, feeding and respiration<br>*A. Display information in a diagrammatic or logical form.*<br>*B. Add brief notes to a diagram or graph.* |
| 9.2 [18] **Explain** how ecosystems are both carbon sinks and carbon sources<br>*A. Give a detailed account including reasons or causes.* |
| 9.2 [19] **Describe** the release of carbon dioxide into the atmosphere during combustion of biomass, peat, coal, oil and natural gas<br>*A. Give a detailed account.* |
| 9.2 [20] **analyze** the Keeling Curve in terms of photosynthesis, respiration and combustion<br>*A. Break down in order to bring out the essential elements or structure.* |
| 9.2 [21] **analyze** the dependence of aerobic respiration on atmospheric oxygen produced by photosynthesis, and of photosynthesis on atmospheric carbon dioxide produced by respiration<br>*A. Break down in order to bring out the essential elements or structure.* |
| 9.2 [22] **Discuss** how the recycling of all chemical elements is required by living organisms in ecosystems<br>*A. Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.* |

| **IB Biology SL & HL, Year 2** **Suggested Pacing: 5 sessions**<br>**Unit 9 : Ecology**<br>**Section 9.3: Populations and Communities** |
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| **IB Guiding Questions** |
| C4.1.a How do interactions between organisms regulate sizes of populations in a community?<br>C4.1.b What interactions within a community make its populations interdependent? |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: |
| 9.3 [1] **Describe** populations as interacting groups of organisms of the same species living in an area<br>*A. Give a detailed account.* |
| 9.3 [2] **Evaluate** estimation of population size by random sampling and recognize (NOS) results of sampling error<br>*A. Make an appraisal by weighing up the strengths and limitations.* |
| 9.3 [3] **Calculate** an estimated population size by conducting random quadrat sampling for sessile organisms |
| 9.3 [4] **Calculate** an estimated population size by capture– mark– release– recapture and the Lincoln index for motile organisms<br>*A. Obtain a numerical answer showing the relevant stages in the working.* |
| 9.3 [5] **Define** carrying capacity and **identify** competition for limited resources<br>*A. Give the precise meaning of a word, phrase, concept or physical quantity.*<br>*B. Provide an answer from a number of possibilities.* |
| 9.3 [6] **Explain** negative feedback control of population size by density-dependent factors (i.e. competition, risk of predation and the transfer of pathogens or pests in dense populations) |
| 9.3 [7a] **Explain** and population growth curves through the analysis of a case study and recognize (NOS) that the curve is an idealized graphical model that acts as a simplification of complex systems<br>*A. Give a detailed account including reasons or causes.*<br><br>9.3 [7b] **Construct** a graph with a logarithmic scale for size of population on the vertical axis and a nonlogarithmic scale for time on the horizontal axis that tests growth of a population against the model of exponential growth<br>*A. Display information in a diagrammatic or logical form.* |
| 9.3 [8] **Construct** the sigmoid population growth curve from collected data<br>*A. Display information in a diagrammatic or logical form.* |
| 9.3 [9] **Distinguish** competition versus cooperation in intraspecific relationships using examples<br>*A. Make clear the differences between two or more concepts or items.* |
| 9.3 [10] **Define** a community as all of the interacting organisms in an ecosystem<br>*A. Give the precise meaning of a word, phrase, concept or physical quantity.* |
| 9.3 [11] **Compare and contrast** herbivory, predation, interspecific competition, mutualism, parasitism and pathogenicity as categories of interspecific relationship within communities using specific examples<br>*A. Give an account of similarities and differences between two (or more) items or situations, referring to both (all) of them throughout.* |
| 9.3 [12] **Describe** mutualism as an interspecific relationship that benefits both species (i.e. root nodules in Fabaceae (legume family), mycorrhizae in Orchidaceae (orchid family) and zooxanthellae in hard corals)<br>*A. Give a detailed account.* |
| 9.3 [13] **Analyze** resource competition between endemic and invasive species using a local example<br>*A. Break down in order to bring out the essential elements or structure.* |
| 9.3 [14] **Outline** tests for interspecific competition and recognize (NOS) hypotheses can be tested by both experiments and observations and should understand the difference between them<br>*A. Give a brief account or summary.* |
| 9.3 [15] **Calculate** and **comment** based on the chi-squared test for association between two species<br>*A. Obtain a numerical answer showing the relevant stages in the working.*<br>*B. Give a judgement based on a given statement or result of a calculation.* |
| 9.3 [16] **Analyze** predator–prey relationships as an example of density-dependent control of animal populations through the use of |

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| a case study<br>*A. Break down in order to bring out the essential elements or structure.* |
| 9.3 [17] **Compare and contrast** top-down and bottom-up control of populations in communities<br>*A. Give an account of similarities and differences between two (or more) items or situations, referring to both (all) of them throughout.* |
| 9.3 [18] **Outline** allelopathy and secretion of antibiotics<br>*A. Give a brief account or summary.* |

| **IB Biology SL & HL, Year 2**<br>**Unit 9 : Ecology**<br>**Section 9.4: Ecological Niches** | **Suggested Pacing: 4 sessions** |
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| **IB Guiding Questions** | |
| B4.2.a What are the advantages of specialized modes of nutrition to living organisms?<br>B4.2.b How are the adaptations of a species related to its niche in an ecosystem? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 9.4 [1] **Define** ecological niche as the role of a species in an ecosystem (e.g. the biotic and abiotic interactions that influence growth, survival and reproduction, including how a species obtains food<br>*A. Give the precise meaning of a word, phrase, concept or physical quantity.* | |
| 9.4 [2] **Contrast** organisms that are obligate anaerobes, facultative anaerobes and obligate aerobes (i.e. limit to the tolerance of these groups of organisms to the presence or absence of oxygen gas in their environment.<br>*A. Give an account of differences between two (or more) items or situations, referring to both (all) of them throughout.* | |
| 9.4 [3] **Describe** photosynthesis as the mode of nutrition in plants, algae and several groups of photosynthetic prokaryotes<br>*A. Give a detailed account.* | |
| 9.4 [4] **Describe** holozoic nutrition in animals (i.e. food is ingested, digested internally, absorbed and assimilated)<br>*A. Give a detailed account.* | |
| 9.4 [5] **Discuss** mixotrophic nutrition in some protists and **contrast** obligate and facultative mixotrophs (e.g. Euglena)<br>*A. Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.* | |
| 9.4 [6] **Describe** saprotrophic nutrition in some fungi and bacteria<br>*A. Give a detailed account.* | |
| 9.4 [7] **Discuss** the diversity of nutrition in archaea<br>*A. Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.* | |
| 9.4 [8] **Distinguish** between dentition and the diet of omnivorous and herbivorous representative members of the family Hominidae, realizing (NOS) that deductions can be made from theories (i.e. use models or digital collections of skulls)<br>*A. Make clear the differences between two or more concepts or items.* | |
| 9.4 [9] **List** adaptations of herbivores for feeding on plants (e.g. include piercing and chewing mouthparts of leaf-eating insects) and of plants for resisting herbivory (e.g. using thorns and other physical structures, toxins)<br>*A. Give a sequence of brief answers with no explanation.* | |
| 9.4 [10] **Describe** the adaptations of predators for finding, catching and killing prey and of prey animals for resisting predation (e.g. chemical, physical and behavioural adaptations)<br>*A. Give a detailed account.* | |
| 9.4 [11] **List** adaptations of plant form for harvesting light (e.g. trees that reach the canopy, lianas, epiphytes growing on branches of trees, strangler epiphytes, shade-tolerant shrubs and herbs growing on the forest floor)<br>*A. Give a sequence of brief answers with no explanation.* | |

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| 9.4 [12] **Compare** and **contrast** fundamental and realized niches<br>*A. Give an account of similarities and differences between two (or more) items or situations, referring to both (all) of them throughout.* |
| 9.4 [13] **Define** competitive exclusion and discuss the uniqueness of ecological niches (i.e. elimination of one of the competing species or the restriction of both to a part of their fundamental niche as possible outcomes of competition between two species)<br>*A. Give the precise meaning of a word, phrase, concept or physical quantity.* |

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| **IB Biology SL & HL, Year 2**<br>**Unit 9 : Ecology**<br>**Section 9.5: Internal Assessment** | **Suggested Pacing: 2 sessions** |
| **IB Guiding Questions** | |
| AO2b Understand and apply knowledge of skills, techniques and methodologies.<br>AO3a analyze, evaluate, and synthesize experimental procedures | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 9.5 [1] **Identify** and **record** relevant qualitative observations.<br>*Skill: Collecting data* | |
| 9.5 [2] **Collect** and **record** sufficient relevant quantitative data.<br>*Skill: Collecting data* | |
| 9.5 [3] **Identify** and **address** issues that arise during data collection.<br>*Skill: Collecting data* | |

| **IB Biology SL & HL, Year 2**<br>**Unit 10: Ecological Stability**<br>**Section 10.1: Stability and Change** | **Suggested Pacing: 6 sessions** |
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| **IB Guiding Questions** | |
| D4.2.a What features of ecosystems allow stability over unlimited time periods?<br>D4.2.b What changes caused by humans threaten the stability of ecosystems? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 10.1 [1] **Deduce** stability as a property of natural ecosystems (i.e. forest, desert)<br>*A. Reach a conclusion from the information given.* | |
| 10.1 [2] **Outline** requirements for stability in ecosystems (i.e. supply of energy, recycling of nutrients, genetic diversity and climatic variables remaining within tolerance levels)<br>*A. Give a brief account or summary.* | |
| 10.1 [3] **Analyze** and **calculate** percent change in deforestation of Amazon rainforest as an example of a possible tipping point in ecosystem stability (i.e. need for a large area of rainforest for the generation of atmospheric water vapour by transpiration, with consequent cooling, air flows and rainfall)<br>*A. Break down in order to bring out the essential elements or structure.*<br>*B. Obtain a numerical answer showing the relevant stages in the working.* | |
| 10.1 [4] **Analyze** the use of a model (mesocosm) to investigate the effect of variables on ecosystem stability<br>*A. Break down in order to bring out the essential elements or structure.* | |
| 10.1 [5] **Explain** the role of keystone species in the stability of ecosystems<br>*A. Give a detailed account including reasons or causes.* | |
| 10.1 [6] **Analyze** the assessment of sustainability of resource harvesting from natural ecosystems (e.g. one plant species, one marine species)<br>*A. Break down in order to bring out the essential elements or structure.* | |
| 10.1 [7] **Outline** factors affecting the sustainability of agriculture (i.e. soil erosion, leaching of nutrients, supply of fertilizers and other inputs,pollution due to agrochemicals, and carbon footprint)<br>*A. Give a brief account or summary.* | |
| 10.1 [8] **Analyze** effects of eutrophication of aquatic and marine ecosystems due to leaching (i.e. nitrogen and phosphate fertilizers, and increased biochemical oxygen demand (BOD)<br>*A. Break down in order to bring out the essential elements or structure.* | |
| 10.1 [9] **Explain** biomagnification of pollutants in natural ecosystems (e.g. DDT, mercury)<br>*A. Give a detailed account including reasons or causes.* | |
| 10.1 [10] **Analyze** the effects of microplastic and macroplastic pollution of the oceans (e.g. effects of plastic on marine life) and recognize (NOS) that scientists can influence the actions of citizens if they provide clear information about their research findings<br>*A. Break down in order to bring out the essential elements or structure.* | |
| 10.1 [11] **Outline** restoration of natural processes in ecosystems by rewilding using the example of Hinewai Reserve in New Zealand (i.e. reintroduction of apex predators and other keystone species, re-establishment of connectivity of habitats over large areas, and minimization of human impact including by ecological management)<br>*A. Give a brief account or summary.* | |
| 10.1 [12] **Explain** ecological succession and its causes<br>*A. Give a detailed account including reasons or causes.* | |
| 10.1 [13] **Describe** changes occurring during primary succession (i.e. increases in size of plants,amount of primary production, species diversity, complexity of food webs and amount of nutrient cycling)<br>*A. Give a detailed account.* | |
| 10.1 [14] **Describe** cyclical succession in ecosystems using an example<br>*A. Give a detailed account.* | |
| 10.1 [15] **Describe** climax communities and arrested succession (e.g. farm livestock, drainage of wetlands)<br>*A. Give a detailed account.* | |

| **IB Biology SL & HL, Year 2**<br>**Unit 10: Ecological Stability**<br>**Section 10.2: Conservation of Biodiversity** | **Suggested Pacing: 3 sessions** |
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| **IB Guiding Questions** | |
| A4.2.a What factors are causing the sixth mass extinction of species?<br>A4.2.b How can conservationists minimize the loss of biodiversity? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 10.2 [1] **Define** biodiversity as the variety of life in all its forms, levels and combinations (ecosystem, species, genetic)<br>*A. Give the precise meaning of a word, phrase, concept or physical quantity.* | |
| 10.2 [2] **Analyze** comparisons between current number of species on Earth and past levels of biodiversity and recognize (NOS) classification is an example of pattern recognition but the same observations can be classified in different ways<br>*A. Break down in order to bring out the essential elements or structure.* | |
| 10.2 [3] **Analyze** causes of anthropogenic species extinction (e.g. North Island giant moas (Dinornis novaezealandiae), Caribbean monk seals (Neomonachus tropicalis)<br>*A. Break down in order to bring out the essential elements or structure.* | |
| 10.2 [4] **Analyze** causes of ecosystem loss (e.g. loss of mixed dipterocarp forest in Southeast Asia)<br>*A. Break down in order to bring out the essential elements or structure.* | |
| 10.2 [5] **Analyze** the evidence (e.g. surveys of biodiversity in a wide range of habitats around the world) for a biodiversity crisis and recognize (NOS) evidence usually has to come from a published source, which has been peer reviewed and allows methodology to be checked, to be verifiable.<br>*A. Break down in order to bring out the essential elements or structure.* | |
| 10.2 [6] **Outline** causes of the current biodiversity crisis (e.g. human population growth, hunting, over-exploitation; urbanization; deforestation and clearance of land for agriculture with consequent loss of natural habitat; pollution and spread of pests, diseases and invasive alien species due to global transport)<br>*A. Give a brief account or summary.* | |
| 10.2 [7] **Evaluate** the need for several approaches to conservation of biodiversity (in situ conservation of species in natural habitats, management of nature reserves, rewilding and reclamation of degraded ecosystems, ex situ conservation in zoos and botanic gardens and storage of germ plasm in seed or tissue banks)<br>*A. Make an appraisal by weighing up the strengths and limitations.* | |
| 10.2 [8] **Evaluate** selection of evolutionarily distinct and globally endangered species for conservation prioritization in the EDGE of Existence programme and recognize (NOS) which species should be prioritized for conservation efforts have complex ethical, environmental, political, social, cultural and economic implications and therefore need to be debated<br>*A. Make an appraisal by weighing up the strengths and limitations.* | |

| **IB Biology SL & HL, Year 2**<br>**Unit 10: Ecological Stability**<br>**Section 10.3: Climate Change** | **Suggested Pacing: 4 sessions** |
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| **IB Guiding Questions** | |
| D4.3.a What are the drivers of climate change?<br>D4.3.b What are the impacts of climate change on ecosystems? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 10.3 [1] **Identify** anthropogenic causes of climate change (i.e. increases in atmospheric concentrations of carbon dioxide and methane), distinguishing (NOS) between positive and negative correlation as well as correlation and causation<br>*A. Provide an answer from a number of possibilities.* | |
| 10.3 [2] **Discuss** positive feedback cycles in global warming (i.e. release of carbon dioxide from deep ocean, increases in absorption of solar radiation due to loss of reflective snow and ice, accelerating rates of decomposition of peat and previously undecomposed organic matter in permafrost, release of methane from melting permafrost and increases in droughts and forest fire | |

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| *A. Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.* |
| 10.3 [3] **Outline** the range from net carbon accumulation to net loss in boreal forests as an example of a tipping point (e.g. warmer temperatures and decreased winter snowfall leading to increased incidence of drought and reductions in primary production in taiga, with forest browning and increases in the frequency and intensity of forest fires, which result in legacy carbon combustion)<br>*A. Give a brief account or summary.* |
| 10.3 [4] **Describe** the melting of landfast ice and sea ice as examples of polar habitat change (e.g. potential loss of breeding grounds of the emperor penguin (Aptenodytes forsteri) due to early breakout of landfast ice in the Antarctic and loss of sea ice habitat for walruses in the Arctic)<br>*A. Give a detailed account.* |
| 10.3 [5] **Discuss** how changes in ocean currents altering the timing and extent of nutrient upwelling<br>*A. Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.* |
| 10.3 [6] **analyze** poleward and upslope range shifts of temperate species evidence-based examples, include upslope range shifts for tropical-zone montane bird species in New Guinea and range contraction and northward spread in North American tree species)<br>*A. Break down in order to bring out the essential elements or structure.* |
| 10.3 [7] **Outline** threats to coral reefs as an example of potential ecosystem collapse (e.g. carbon dioxide concentrations are the cause of ocean acidification and suppression of calcification in corals. Increases in water temperature are a cause of coral bleaching. Loss of corals causes the collapse of reef ecosystems)<br>*A. Give a brief account or summary.* |
| 10.3 [8] **List** afforestation, forest regeneration and restoration of peat-forming wetlands as approaches to carbon sequestration, realizing (NOS) that here is active scientific debate over whether plantations of non-native tree species or rewilding with native species offer the best approach to carbon sequestration<br>*A. Give a sequence of brief answers with no explanation.* |
| 10.3 [9] **Identify** phenology as research into the timing of biological events (e.g. photoperiod, temperature patterns)<br>*A. Provide an answer from a number of possibilities.* |
| 10.3 [10] **Discuss** the disruption to the synchrony of phenological events by climate change, recognizing that within an ecosystem temperature may act as the cue in one population and photoperiod may be the cue in another (e.g. spring growth of the Arctic mouse-ear chickweed (Cerastium arcticum) and arrival of migrating reindeer (Rangifer tarandus) as one example. Also, the breeding of the great tit (Parus major) and peak biomass of caterpillars in north European forests as another)<br>*A. Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.* |
| 10.3 [11] **Describe** increases to the number of insect life cycles within a year due to climate change (i.e. spruce bark beetle (Ips typographus or Dendroctonus micans))<br>*A. Give a detailed account.* |
| 10.3 [12] **Identify** evolution as a consequence of climate change (i.e. changes in the fitness of colour variants of the tawny owl (Strix aluco) as a consequence of changes in snow cover)<br>*A. Provide an answer from a number of possibilities.* |

| **IB Biology SL & HL, Year 2**<br>**Unit 10: Ecological Stability**<br>**Section 10.4: Internal Assessment** | **Suggested Pacing: 2 sessions** |
|---|---|
| **IB Guiding Questions** | |
| AO2b Understand and apply knowledge of skills, techniques and methodologies.<br>AO3a analyze, evaluate, and synthesize experimental procedures<br>AO3b analyze, evaluate, and synthesize primary and secondary data<br>AO3c analyze, evaluate, and synthesize trends, patterns and predictions | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 10.4 [1] Carry out relevant and accurate data processing.<br>*Skill: Processing data* | |
| 10.4 [2] Interpret qualitative and quantitative data.<br>*Skill: Interpreting results* | |
| 10.4 [3] Interpret diagrams, graphs and charts.<br>*Skill: Interpreting results* | |
| 10.4 [4] Identify, describe and explain patterns, trends and relationships.<br>*Skill: Interpreting results* | |
| 10.4 [5] Identify and justify the removal or inclusion of outliers in data (no mathematical processing is required).<br>*Skill: Interpreting results* | |
| 10.4 [6] Assess accuracy, precision, reliability and validity.<br>*Skill: Interpreting results* | |
| Meet individually and discuss draft | |

| **IB Biology SL & HL, Year 2**<br>**Unit 11: Homeostasis and Cell Communication**<br>**Section 11.1: Homeostasis** | **Suggested Pacing: 4 sessions** |
|---|---|
| **IB Guiding Questions** | |
| D3.3.a How are constant internal conditions maintained in humans?<br>D3.3.b What are the benefits to organisms of maintaining constant internal conditions? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 11.1 [1] **Describe** homeostasis as maintenance of the internal environment of an organism (e.g. body temperature, blood pH, blood glucose concentration and blood osmotic concentration in humans)<br>*A. Give a detailed account.* | |
| 11.1 [2] **Explain** negative feedback loops in homeostasis<br>*A. Give a detailed account including reasons or causes.* | |
| 11.1 [3] **Explain** regulation of blood glucose as an example of the role of hormones in homeostasis (i.e. control of secretion of insulin and glucagon by pancreatic endocrine cells, transport in blood and the effects on target cells)<br>*A. Give a detailed account including reasons or causes.* | |
| 11.1 [4] **Outline** physiological changes that form the basis of type 1 and type 2 diabetes (i.e. risk factors and methods of prevention and treatment)<br>*A. Give a brief account or summary.* | |
| 11.1 [5] **Explain** thermoregulation as an example of negative feedback control (i.e. roles of peripheral thermoreceptors, the hypothalamus and pituitary gland, thyroxin and also examples of muscle and adipose tissue that act as effectors of temperature change)<br>*A. Give a detailed account including reasons or causes.* | |
| 11.1 [6] **Describe** thermoregulation mechanisms in humans (i.e. vasodilation, vasoconstriction, shivering, sweating, uncoupled respiration in brown adipose tissue and hair erection)<br>*A. Give a detailed account.* | |
| 11.1 [7] **Distinguish** the role of the kidney in osmoregulation and excretion<br>*A. Make clear the differences between two or more concepts or items.* | |
| 11.1 [8] **Describe** the role of the glomerulus, Bowman's capsule and proximal convoluted tubule in excretion<br>*A. Give a detailed account.* | |
| 11.1 [9] **Describe** the role of the loop of Henle<br>*A. Give a detailed account.* | |
| 11.1 [10] **Explain** osmoregulation by water reabsorption in the collecting ducts (i.e. roles of osmoreceptors in the hypothalamus, changes to the rate of antidiuretic hormone secretion by the pituitary gland and the resultant switches in location of aquaporins between cell membranes and intracellular vesicles in cells of the collecting ducts)<br>*A. Give a detailed account including reasons or causes.* | |
| 11.1 [11] 1 **Explain** changes in blood supply to organs in response to changes in activity (e.g. the pattern of blood supply to the skeletal muscles, gut, brain and kidneys during sleep, vigorous physical activity and wakeful rest)<br>*A. Give a detailed account including reasons or causes.* | |

| **IB Biology SL & HL, Year 2**<br>**Unit 11: Homeostasis and Cell Communication**<br>**Section 11.2: Chemical Signalling** | **Suggested Pacing: 3 sessions** |
|---|---|
| **IB Guiding Questions** | |
| C2.1.a How do cells distinguish between the many different signals that they receive?<br>C2.1.b What interactions occur inside animal cells in response to chemical signals? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 11.2 [1] **Identify** receptors as proteins with binding sites for specific signalling chemicals (ligands)<br>*A. Provide an answer from a number of possibilities.* | |
| 11.2 [2] **Describe** cell signalling by bacteria in quorum sensing (e.g. bioluminescence in the marine bacterium Vibrio fischeri).<br>*A. Give a detailed account.* | |
| 11.2 [3]**Distinguish** hormones, neurotransmitters, cytokines and calcium ions as examples of functional categories of signalling chemicals in animals<br>*A. Make clear the differences between two or more concepts or items.* | |
| 11.2 [4] **Outline** the chemical diversity of hormones (e.g. amines, proteins and steroids) and neurotransmitters (e.g. amino acids, peptides, amines and nitrous oxide) | |
| 11.2 [5] **Compare** and **contrast** localized and distant effects of signalling molecules | |
| 11.2 [6] **Distinguish** differences between transmembrane receptors in a plasma membrane and intracellular receptors in the cytoplasm or nucleus (i.e. distribution of hydrophilic or hydrophobic amino acids in the receptor and whether the signalling chemical penetrates the cell or remains outside)<br>*A. Make clear the differences between two or more concepts or items.* | |
| 11.2 [7] **Describe** initiation of signal transduction pathways by receptors<br>*A. Give a detailed account.* | |
| 11.2 [8] **Describe** transmembrane receptors for neurotransmitters and changes to membrane potential (e.g. acetylcholine receptor)<br>*A. Give a detailed account.* | |
| 11.2 [9] **Describe** transmembrane receptors that activate G proteins<br>*A. Give a detailed account.* | |
| 11.2 [10] **Explain** the mechanism of action of epinephrine (adrenaline) receptors (i.e. roles of G protein and cyclic AMP (cAMP) as the second messenger) and recognize (NOS) naming conventions are an example of international cooperation in science for mutual benefit.<br>*A. Give a detailed account including reasons or causes.* | |
| 11.2 [11] **Describe** transmembrane receptors with tyrosine kinase activity (e.g. insulin)<br>*A. Give a detailed account.* | |
| 11.2 [12]**Describe** intracellular receptors that affect gene expression (e.g. oestradiol, progesterone and testosterone)<br>*A. Give a detailed account.* | |
| 11.2 [13] **Outline** effects of the hormones oestradiol and progesterone on target cells<br>*A. Give a brief account or summary.* | |
| 11.2 [14] **Distinguish** regulation of cell signalling pathways by positive and negative feedback<br>*A. Make clear the differences between two or more concepts or items.* | |

| **IB Biology SL & HL, Year 2**<br>**Unit 11: Homeostasis and Cell Communication**<br>**Section 11.3: Internal Assessment** | **Suggested Pacing: 3 sessions** |
|---|---|
| **IB Guiding Questions** | |
| AO1b Demonstrate knowledge of skills, techniques and methodologies.<br>AO2b Understand and apply knowledge of skills, techniques and methodologies.<br>AO3b analyze, evaluate, and synthesize primary and secondary data<br>AO3c analyze, evaluate, and synthesize trends, patterns and predictions<br>AO4 Demonstrate the application of skills necessary to carry out insightful and ethical investigations. | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 11.3 [1] Interpret processed data and analysis to draw and justify conclusions.<br>*Skill: Concluding* | |
| 11.3 [2] Compare the outcomes of an investigation to the accepted scientific context.<br>*Skill*: *Concluding* | |
| 11.3 [3] Relate the outcomes of an investigation to the stated research question or hypothesis.<br>*Skill: Concluding* | |
| 11.3 [4] Discuss the impact of uncertainties on the conclusion.<br>*Skill: Concluding* | |
| 11.3 [5]Evaluate hypothesis.<br>*Skill*: *Evaluating* | |
| 11.3 [6] Identify and discuss sources and impacts of random and systematic errors.<br>*Skill: Evaluating* | |
| 11.3 [7] Evaluate the implications of methodological weaknesses, limitations and assumptions on conclusions.<br>*Skill: Evaluating* | |
| 11.3 [8] Explain realistic and relevant improvements to an investigation.<br>*Skill: Evaluating* | |
| Final IA submission | |

| **IB Biology SL & HL, Year 2**<br>**Unit 11: Homeostasis and Cell Communication**<br>**Section 11.4: Neural Signalling** | **Suggested Pacing: 6 sessions** |
|---|---|
| **IB Guiding Questions** | |
| C2.2.a How are electrical signals generated and moved within neurons?<br>C2.2.b How can neurons interact with other cells? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 11.4 [1] **Identify** neurons as cells within the nervous system that carry electrical impulses (i.e. cell body, axon, dendrites)<br>*A. Provide an answer from a number of possibilities.* | |
| 11.4 [2] **Determine** how the resting potential is generated (i.e. sodium and potassium ion pumping to establish and maintain concentration gradients of sodium and potassium ions)<br>*A. Obtain the only possible answer.* | |
| 11.4 [3] **Describe** nerve impulses as action potentials that are propagated along nerve fibres (i.e. electrical, movement of positively charged ions) | |
| 11.4 [4] **Compare** the variation in the speed of nerve impulses (i.e. transmission in giant axons of squid and smaller non-myelinated nerve fibres, the speed in myelinated and non-myelinated fibres) and **analyze** correlation coefficients to evaluate the degree to which variation in the independent variable explains the variation in the dependent variable<br>*A. Give an account of similarities between two (or more) items or situations, referring to both (all) of them throughout.*<br>*B. Break down in order to bring out the essential elements or structure.* | |
| 11.4 [5] **Identify** chemical synapses as junctions between neurons and between neurons and effector cells (i.e. signal passes in one direction across the synapse)<br>*A. Provide an answer from a number of possibilities.* | |
| 11.4 [6] **Outline** the release of neurotransmitters from a presynaptic membrane (i.e. uptake of calcium in response to depolarization of a presynaptic membrane and its action as a signalling chemical inside a neuron)<br>*A.Give a brief account or summary.* | |
| 11.4 [7] **Outline** the generation of an excitatory postsynaptic potential (e.g. acetylcholine)<br>*A.Give a brief account or summary.* | |
| 11.4 [8] **Describe** depolarization and repolarization during action potentials (action of voltage-gated sodium and potassium channels and the need for a threshold potential to be reached for sodium channels to open)<br>*A. Give a detailed account.* | |
| 11.4 [9] **Outline** the release of neurotransmitters from a presynaptic membrane<br>*A.Give a brief account or summary.* | |
| 11.4 [10] **Analyze** oscilloscope traces showing resting potentials and action potentials and measure number of impulses per second<br>*A. Break down in order to bring out the essential elements or structure.* | |
| 11.4 [11] **Explain** how saltatory conduction in myelinated fibres achieves faster impulses | |
| 11.4 [12] **Describe** effects of exogenous chemicals on synaptic transmission (e.g. neonicotinoids, cocaine)<br>*A. Give a detailed account.* | |
| 11.4 [13] **Describe** inhibitory neurotransmitters and generation of inhibitory postsynaptic potentials<br>*A. Give a detailed account.* | |
| 11.4 [14] **Describe** summation of the effects of excitatory and inhibitory neurotransmitters in a postsynaptic neuron<br>*A. Give a detailed account.* | |
| 11.4 [15] **Describe** perception of pain by neurons with free nerve endings in the skin<br>*A. Give a detailed account.* | |
| 11.4 [16] **Define** consciousness as a property that emerges from the interaction of individual neurons in the brain<br>*A. Give the precise meaning of a word, phrase, concept or physical quantity.* | |

| **IB Biology SL & HL, Year 2** **Suggested Pacing: 7 sessions**<br>**Unit 12: Integration of Body Systems**<br>**Section 12.1: Integration of body systems** |
|---|
| **IB Guiding Questions** |
| C3.1.a What are the roles of nerves and hormones in integration of body systems?<br>C3.1.b What are the roles of feedback mechanisms in regulation of body systems? |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: |
| 12.1 [1] **Justify** system integration as a necessary process in living systems to collectively performance an overall function<br>*A. Give valid reasons or evidence to support an answer or conclusion.* |
| 12.1 [2] **Identify** cells, tissues, organs and body systems as a hierarchy of subsystems that are integrated in a multicellular living organism<br>*A. Provide an answer from a number of possibilities.* |
| 12.1 [3] **Compare** and **contrast** the integration of organs in animal bodies by hormonal and nervous signalling and by transport of materials and energy<br>*A. Give an account of similarities and differences between two (or more) items or situations, referring to both (all) of them throughout.* |
| 12.1 [4] **Identify** the brain as a central information integration organ<br>*A. Provide an answer from a number of possibilities.* |
| 12.1 [5] **Identify** the spinal cord as an integrating centre for unconscious processes<br>*A. Provide an answer from a number of possibilities.* |
| 12.1 [6] **Describe** the role of sensory neurons as an input to the spinal cord and cerebral hemispheres<br>*A. Give a detailed account.* |
| 12.1 [7] **Describe** the role of the cerebral hemisphere as an output to muscles through motor neurons<br>*A. Give a detailed account.* |
| 12.1 [8] **Describe** nerves as bundles of nerve fibres of both sensory and motor neurons and annotate a transverse section of a nerve to show the protective sheath, and myelinated and unmyelinated nerve fibres<br>*A. Give a detailed account.* |
| 12.1 [9] **Describe** pain reflex arcs as an example of involuntary responses with skeletal muscle as the effector<br>*A. Give a detailed account.* |
| 12.1 [10] **Describe** the role of the cerebellum in coordinating skeletal muscle contraction and balance<br>*A. Give a detailed account.* |
| 12.1 [11] **Explain** the modulation of sleep patterns by melatonin secretion as a part of circadian rhythms<br>*A. Give a detailed account including reasons or causes.* |
| 12.1 [12] **Explain** the secretion of epinephrine (adrenaline) by the adrenal glands to prepare the body for vigorous activity<br>*A. Give a detailed account including reasons or causes.* |
| 12.1 [13] **Describe** control of the endocrine system by the hypothalamus and pituitary gland<br>*A. Give a detailed account.* |
| 12.1 [14] **Explain** feedback control of heart rate following sensory input from baroreceptors and chemoreceptors<br>*A. Give a detailed account including reasons or causes.* |
| 12.1 [15] **Explain** feedback control of ventilation rate following sensory input from chemoreceptors<br>*A. Give a detailed account including reasons or causes.* |
| 12.1 [16] **Explain** control of peristalsis in the digestive system by the central nervous system and enteric nervous system<br>*A. Give a detailed account including reasons or causes.* |
| 12.1 [17] **Analyze** observations of tropic responses in seedlings using data and **distinguish** (NOS) between qualitative and quantitative observations and understand factors that limit the precision of measurements and their accuracy<br>*A. Break down in order to bring out the essential elements or structure.*<br>*B. Make clear the differences between two or more concepts or items.* |
| 12.1 [18] **Identify** positive phototropism as a directional growth response to lateral light in plant shoots<br>*A. Provide an answer from a number of possibilities.* |

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| 12.1 [19] **Identify** phytohormones as signaling chemicals controlling growth, development and response to stimuli in plants<br>*A. Provide an answer from a number of possibilities.* |
| 12.1 [20] **Explain** how auxin efflux carriers are an an example of maintaining concentration gradients of phytohormones<br>*A. Give a detailed account including reasons or causes.* |
| 12.1 [21] **Describe** promotion of cell growth by auxin (i.e. auxin's promotion of hydrogen ion secretion into the apoplast, acidifying the cell wall and thus loosening cross links between cellulose molecules and facilitating cell elongation)<br>*A. Give a detailed account.* |
| 12.1 [22] **Describe** interactions between auxin and cytokinin as a means of regulating root and shoot growth<br>*A. Give a detailed account.* |
| 12.1 [23] **Explain** positive feedback in fruit ripening and ethylene production<br>*A. Give a detailed account including reasons or causes.* |

| **IB Biology SL & HL, Year 2**<br>**Unit 12: Integration of Body Systems**<br>**Section 12.2: Muscle and Motility** | **Suggested Pacing: 3 sessions** |
|---|---|
| **IB Guiding Questions** | |
| B3.3.a How do muscles contract and cause movement?<br>B3.3.b What are the benefits to animals of having muscle tissue? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 12.2 [1] **Justify** adaptations for movement as a universal feature of living organisms (e.g. motile and sessile species)<br>*A. Give valid reasons or evidence to support an answer or conclusion.* | |
| 12.2 [2] **Explain** the sliding filament model of muscle contraction<br>*A. Give a detailed account including reasons or causes.* | |
| 12.2 [3] **Describe** the role of the protein titin and antagonistic muscles in muscle relaxation<br>*A. Give a detailed account.* | |
| 12.2 [4] **Describe** the structure and function of motor units in skeletal muscle (i.e. motor neuron, muscle fibres, neuromuscular junctions)<br>*A. Give a detailed account.* | |
| 12.2 [5] **Identify** roles of skeletons as anchorage for muscles and as levers<br>*A. Provide an answer from a number of possibilities.* | |
| 12.2 [6] **Describe** movement at a synovial joint using the human hip as an example (i.e. roles of bones, cartilage, synovial fluid, ligaments, muscles, tendons, femur, and pelvis)<br>*A. Give a detailed account.* | |
| 12.2 [7] **Compare** the range of motion of a joint and **measure** joint angles using computer analysis of images or a goniometer<br>*A. Give an account of similarities between two (or more) items or situations, referring to both (all) of them throughout.*<br>*B. Obtain a value for a quantity.* | |
| 12.2 [8] **Describe** internal and external intercostal muscles as an example of antagonistic muscle action to facilitate internal body movements<br>*A. Give a detailed account.* | |
| 12.2 [9] **Identify** reasons for locomotion (food, escaping from danger, searching for a mate and migration, with at least one example of each)<br>*A. Provide an answer from a number of possibilities.* | |
| 12.2 [10] **Describe** adaptations for swimming in marine mammals (i.e. streamlining, adaptation of limbs to form flippers and of the tail to form a fluke with up-and-down movement, and changes to the airways to allow periodic breathing between dives)<br>*A. Give a detailed account.* | |

| **IB Biology SL & HL, Year 2**<br>**Unit 13: Immune System and Pathogens**<br>**Section 13.1: Defence Versus Disease** | **Suggested Pacing: 5 sessions** |
|---|---|
| **IB Guiding Questions** | |
| C3.2.a How do body systems recognize pathogens and fight infections?<br>C3.2.b What factors influence the incidence of disease in populations? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 13.1 [1] **Identify** pathogens as the cause of infectious diseases, recognizing (NOS) careful observation can lead to important progress<br>*A. Provide an answer from a number of possibilities.* | |
| 13.1 [2] **List** skin and mucous membranes as a primary defense to pathogens<br>*A. Give a sequence of brief answers with no explanation.* | |
| 13.1 [3] **Describe** the sealing of cuts in skin by blood clotting (i.e. clotting factors, fibrinogen to fibrin by thrombin pathway)<br>*A. Give a detailed account.* | |
| 13.1 [4] **Distinguish** between the innate immune system and the adaptive immune system (i.e. the innate system responds to broad categories of pathogen and does not change during an organism's life whereas the adaptive system responds in a specific way to particular pathogens and builds up a memory of pathogens encountered, so the immune response becomes more effective) | |
| 13.1 [5] **Outline** infection control by phagocytes (i.e. amoeboid movement from blood to sites of infection, where phagocytes recognize pathogens, engulf them by endocytosis and digest them using enzymes from lysosome) | |
| 13.1 [6] **Identify** lymphocytes as cells in the adaptive immune system that cooperate to produce antibodies (i.e. lymphocytes both circulate in the blood and are contained in lymph nodes)<br>*A. Provide an answer from a number of possibilities.* | |
| 13.1 [7] **Identify** antigens as recognition molecules that trigger antibody production<br>*A. Provide an answer from a number of possibilities.* | |
| 13.1 [8] **Describe** the activation of B-lymphocytes by helper T-lymphocytes<br>*A. Give a detailed account.* | |
| 13.1 [9] **Describe** how the multiplication of activated B-lymphocytes form clones of antibody-secreting plasma cells (i.e. activated B-cells first divide by mitosis to produce large numbers of plasma B-cells that are capable of producing the same type of antibody)<br>*A. Give a detailed account.* | |
| 13.1 [10] **Identify** immunity as a consequence of retaining memory cells<br>*A. Provide an answer from a number of possibilities.* | |
| 13.1 [11] **Outline** the transmission of HIV in body fluids<br>*A. Give a brief account or summary.* | |
| 13.1 [12] **Outline** the infection of lymphocytes by HIV with AIDS as a consequence<br>*A. Give a brief account or summary.* | |
| 13.1 [13] **Identify** antibiotics as chemicals that block processes occurring in bacteria but not in eukaryotic cells (i.e. reasons that antibiotics fail to control infection with viruses)<br>*A. Provide an answer from a number of possibilities.* | |
| 13.1 [14] **Discuss** the evolution of resistance to several antibiotics in strains of pathogenic bacteria, recognizing (NOS) that the development of new techniques can lead to new avenues of research<br>*A. Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.* | |
| 13.1 [15] **Identify** zoonoses as infectious diseases that can transfer from other species to humans (e.g. tuberculosis, rabies and Japanese encephalitis. Include COVID-19 as an infectious disease that has recently transferred from another species, with profound consequences for humans.)<br>*A. Provide an answer from a number of possibilities.* | |
| 13.1 [16] **Define** vaccines and **describe** the process of immunization<br>*A. Give the precise meaning of a word, phrase, concept or physical quantity.*<br>*B. Give a detailed account.* | |

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| 13.1 [17] **Define** herd immunity and outline the prevention of epidemics, recognizing (NOS) that scientists publish their research so that other scientists can evaluate it<br>*A. Give the precise meaning of a word, phrase, concept or physical quantity.* |
| 13.1 [18] **Evaluate** data related to the COVID-19 pandemic and calculate the percentage difference and percentage change<br>*A. Make an appraisal by weighing up the strengths and limitations.* |

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| **IB Biology SL & HL, Year 2**<br>**Unit 13: Immune System and Pathogens**<br>**Section 13.2: Viruses** | **Suggested Pacing: 2 sessions** |
| **IB Guiding Questions** | |
| A2.3.a How can viruses exist with so few genes?<br>A2.3.b In what ways do viruses vary? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 13.2 [1] **List** the structural features common to viruses (i.e. small, fixed size; nucleic acid (DNA or RNA) as genetic material; a capsid made of protein; no cytoplasm; and few or no enzymes)<br>*A. Give a sequence of brief answers with no explanation.* | |
| 13.2 [2] **Outline** the diversity of structure in viruses (e.g. bacteriophage lambda, coronaviruses and HIV)<br>*A. Give a brief account or summary.* | |
| 13.2 [3] **Outline** the lytic cycle of a virus (e.g. bacteriophage lambda)<br>*A. Give a brief account or summary.* | |
| 13.2 [4] **Outline** the lysogenic cycle of a virus (e.g. bacteriophage lambda)<br>*A. Give a brief account or summary.* | |
| 13.2 [5] **Evaluate** the evidence for several origins of viruses from other organisms (i.e. Viruses share an extreme form of obligate parasitism as a mode of existence, so the structural features that they have in common could be regarded as convergent evolution. The genetic code is shared between viruses and living organisms)<br>*A. Make an appraisal by weighing up the strengths and limitations.* | |
| 13.2 [6] **Explain** rapid evolution in viruses (i.e. influenza viruses and of HIV)<br>*A. Give a detailed account including reasons or causes.* | |

| **IB Biology SL & HL, Year 2**<br>**Unit 14: Respiratory System**<br>**Section 14.1: Transport** | **Suggested Pacing: 6 sessions** |
|---|---|
| **IB Guiding Questions** | |
| B3.2.a What adaptations facilitate transport of fluids in animals and plants?<br>B3.2.b What are the differences and similarities between transport in animals and plants? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 14.1 [1] **Outline** release and reuptake of tissue fluid in capillaries<br>*A. Give a brief account or summary.* | |
| 14.1 [2] **Outline** the exchange of substances between tissue fluid and cells in tissues<br>*A. Give a brief account or summary.* | |
| 14.1 [3] **Outline** drainage of excess tissue fluid into lymph ducts<br>*A. Give a brief account or summary.* | |
| 14.1 [4] **Distinguish** differences between the single circulation of bony fish and the double circulation of mammals<br>*A. Make clear the differences between two or more concepts or items.* | |
| 14.1 [5] Using a diagram, **describe** and **identify** form-function adaptations (i.e. cardiac muscle, pacemaker, atria, ventricles, atrioventricular and semilunar valves, septum and coronary vessels) of the mammalian heart for delivering pressurized blood to the arteries and **sketch** the unidirectional flow of blood from named veins to arteries<br>*A. Give a detailed account.*<br>*B. Provide an answer from a number of possibilities.*<br>*C. Represent by means of a diagram or graph (labeled as appropriate). The sketch should give a general idea of the required shape or relationship, and should include relevant features.* | |
| 14.1 [6] **Describe** the stages in the cardiac cycle and **deduce** systolic and diastolic blood pressure measurements from data and graphs.<br>*A. Give a detailed account.*<br>*B. Reach a conclusion from the information given.* | |
| 14.1 [7] Evaluate causes and consequences of occlusion of the coronary arteries (i.e. coronary heart disease) and understand (NOS) correlation coefficients quantify correlations between variables and allow the strength of the relationship to be assessed<br>*A. Make an appraisal by weighing up the strengths and limitations.* | |

| **IB Biology SL & HL, Year 2**<br>**Unit 14: Respiratory System**<br>**Section 14.2: Gas Exchange** | **Suggested Pacing: 3 sessions** |
|---|---|
| **IB Guiding Questions** | |
| B3.1.a How are multicellular organisms adapted to carry out gas exchange?<br>B3.1.b What are the similarities and differences in gas exchange between a flowering plant and a mammal? | |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: | |
| 14.2 [1] **Explain** how concentration gradients at exchange surfaces in animals are maintained (e.g. dense networks of blood vessels, continuous blood flow, and ventilation with air for lungs and with water for gills)<br>*A. Give a detailed account including reasons or causes.* | |
| 14.2 [2] **Outline** the adaptations of mammalian lungs for gas exchange in the alveolar lungs of a mammal.<br>*A. Give a brief account or summary.* | |
| 14.2 [3] **Discuss** the role of the diaphragm, intercostal muscles, abdominal muscles and ribs in the ventilation of the lungs<br>*A. Offer a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.* | |
| 14.2 [4] **Measure** lung volumes and **determine** tidal volume, vital capacity and inspiratory and expiratory reserves<br>*A. Obtain a value for a quantity.*<br>*B. Obtain the only possible answer.* | |
| 14.2 [5] **Describe** adaptations of foetal and adult haemoglobin for the transport of oxygen (i.e. cooperative binding of oxygen to haem groups and allosteric binding of carbon dioxide)<br>*A. Give a detailed account.* | |
| 14.2 [6] **Explain** the cause and benefits of the Bohr shift in actively respiring tissues.<br>*A. Give a detailed account including reasons or causes.* | |
| 14.2 [7] **Explain** oxygen dissociation curves as a means of representing the affinity of haemoglobin for oxygen at different oxygen concentrations<br>*A. Give a detailed account including reasons or causes.* | |

| **IB Biology SL & HL, Year 2** **Suggested Pacing: 8 sessions**<br>**Unit 15: Reproductive System and Cell Specialization**<br>**Section 15.1: Reproduction** |
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| **IB Guiding Questions** |
| D3.1.a How does asexual or sexual reproduction exemplify themes of change or continuity?<br>D3.1.b What changes within organisms are required for reproduction? |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: |
| 15.1 [1] **Distinguish** differences between sexual and asexual reproduction (i.e. asexual reproduction to produce genetically identical offspring by individuals that are adapted to an existing environment, sexual reproduction to produce offspring with new gene combinations and thus variation needed for adaptation to a changed environment)<br>*A. Make clear the differences between two or more concepts or items.* |
| 15.1 [2] **Describe** role of meiosis and fusion of gametes in the sexual life cycle<br>*A. Give a detailed account.* |
| 15.1 [3] **Distinguish** differences between male and female sexes in sexual reproduction (i.e. prime difference that the male gamete travels to the female gamete, so it is smaller, with less food reserves than the egg, and numbers of gametes and the reproductive strategies of males and females)<br>*A. Make clear the differences between two or more concepts or items.* |
| 15.1 [4] **Draw** and **annotate** diagrams of the anatomy of the human male and female reproductive systems<br>*A. Represent by means of a labeled, accurate diagram or graph, using a pencil. A ruler (straight edge) should be used for straight lines. Diagrams should be drawn to scale. Graphs should have points correctly plotted (if appropriate) and joined in a straight line or smooth curve.*<br>*B. Add brief notes to a diagram or graph.* |
| 15.1 [5] **Describe** changes during the ovarian and uterine cycles and their hormonal regulation (i.e. oestradiol, progesterone, luteinizing hormone (LH), follicle-stimulating hormone (FSH) and both positive and negative feedback)<br>*A. Give a detailed account.* |
| 15.1 [6] **Describe** fertilization in humans (i.e. fusion of a sperm's cell membrane with an egg cell membrane, entry to the egg of the sperm nucleus but destruction of the tail and mitochondria, dissolution of nuclear membranes of sperm and egg nuclei and participation of all the condensed chromosomes in a joint mitosis to produce two diploid nuclei)<br>*A. Give a detailed account.* |
| 15.1 [7] **Outline** use of hormones in in vitro fertilization (IVF) treatment<br>*A. Give a brief account or summary.* |
| 15.1 [8] **Outline** sexual reproduction in flowering plants (i.e. production of gametes inside ovules and pollen grains, pollination, pollen development and fertilization to produce an embryo)<br>*A. Give a brief account or summary.* |
| 15.1 [9] **Draw** and **annotate** diagrams features of an insect-pollinated flower<br>*A. Represent by means of a labeled, accurate diagram or graph, using a pencil. A ruler (straight edge) should be used for straight lines. Diagrams should be drawn to scale. Graphs should have points correctly plotted (if appropriate) and joined in a straight line or smooth curve.*<br>*B. Add brief notes to a diagram or graph.* |
| 15.1 [10] **Describe** methods of promoting cross-pollination (i.e. different maturation times for pollen and stigma, separate male and female flowers or male and female plants, role of animals or wind in transferring pollen between plants)<br>*A. Give a detailed account.* |
| 15.1 [11] **Describe** self-incompatibility mechanisms to increase genetic variation within a species<br>*A. Give a detailed account.* |
| 15.1 [12] **Describe** dispersal and germination of seeds (i.e. growth and development of the embryo and the mobilization of food reserves)<br>*A. Give a detailed account.* |

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| 15.1 [13] **Explain** control of the developmental changes of puberty by gonadotropin-releasing hormone and steroid sex hormones<br>*A. Give a detailed account including reasons or causes.* |
| 15.1 [14] **Distinguish** spermatogenesis and oogenesis in humans (mitosis, cell growth, two divisions of meiosis, differentiation, numbers of sperm and eggs, and amounts of cytoplasm)<br>*A. Make clear the differences between two or more concepts or items.* |
| 15.1 [15] **Outline** mechanisms to prevent polyspermy<br>*A. Give a brief account or summary.* |
| 15.1 [16] **Describe** development of a blastocyst and implantation in the endometrium<br>*A. Give a detailed account.* |
| 15.1 [17] **Describe** pregnancy testing by detection of human chorionic gonadotropin secretion (i.e. production of human chorionic gonadotropin (hCG) in the embryo or developing placenta and the use of monoclonal antibodies that bind to hCG)<br>*A. Give a detailed account.* |
| 15.1 [18] **Explain** the role of the placenta in foetal development inside the uterus<br>*A. Give a detailed account including reasons or causes.* |
| 15.1 [19] **Explain** hormonal control (i.e. progesterone, oxytocin) of pregnancy and childbirth<br>*A. Give a detailed account including reasons or causes.* |
| 15.1 [20] **Analyze** hormone replacement therapy and the risk of coronary heart disease and recognize (NOS) changes in understanding of epidemiological studies<br>*A. Break down in order to bring out the essential elements or structure.* |

| **IB Biology SL & HL, Year 2** **Suggested Pacing: 3 sessions**<br>**Unit 15: Reproductive System and Cell Specialization**<br>**Section 15.2: Cell Specialization** |
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| **IB Guiding Questions** |
| B2.3.a What are the roles of stem cells in multicellular organisms?<br>B2.3.b How are differentiated cells adapted to their specialized functions? |
| **Standards-Aligned Objectives.** Instruction and assessment will align to the following objectives: |
| 15.2 [1] **Describe** the production of unspecialized cells following fertilization and their development into specialized cells by differentiation<br>*A. Give a detailed account.* |
| 15.2 [2] **List** the properties of stem cells (i.e. limit to the capacity of cells to divide endlessly and differentiate along different<br>*A. Give a sequence of brief answers with no explanation.* |
| 15.2 [3] **Outline** the location and function of stem cell niches in adult humans (e.g. bone marrow and hair follicles )<br>*A. Give a brief account or summary.* |
| 15.2 [4] **Distinguish** between totipotent, pluripotent and multipotent stem cells<br>*A. Make clear the differences between two or more concepts or items.* |
| 15.2 [5] **Identify** cell size as an aspect of specialization (i.e. male and female gametes, red and white blood cells, neurons and striated muscle fibres)<br>*A. Provide an answer from a number of possibilities.* |
| 15.2 [6] **Calculate** surface area-to-volume ratios and outline constraints on cell size, recognizing (NOS) that models are simplified versions of complex systems<br>*A. Obtain a numerical answer showing the relevant stages in the working.* |
| 15.2 [7] **List** adaptations to increase surface area-to-volume ratios of cells (e.g. flattening of cells, microvilli and invagination. Use erythrocytes and proximal convoluted tubule cells in the nephron)<br>*A. Give a sequence of brief answers with no explanation.* |
| 15.2 [8] **Outline** adaptations of type I and type II pneumocytes in alveoli (i.e. limit to extreme thinness to reduce distances for diffusion in type I pneumocytes and the presence of many secretory vesicles (lamellar bodies) in the cytoplasm that discharge surfactant to the alveolar lumen in type II pneumocytes)<br>*A. Give a brief account or summary.* |
| 15.2 [9] **Outline** adaptations of cardiac muscle cells and striated muscle fibres (i.e. the presence of contractile myofibrils in both muscle types and hypotheses for these differences: branching (branched or unbranched), and length and numbers of nuclei, and a discussion of whether a striated muscle fibre is a cell)<br>*A. Give a brief account or summary.* |
| 15.2 [10] **List** adaptations of sperm and egg cells<br>*A. Give a sequence of brief answers with no explanation.* |