

International Baccalaureate Course

The International Baccalaureate (IB) biology course is divided into three sections: core, additional higher level material, and option material. All **IB candidates** must complete the **core** topics. Higher level students are also required to undertake Additional Higher Level (**AHL**) material as part of the core. Options fall into three categories (see the following page): those specific to standard

level students (**OPT-SL**), one only specific to higher level students (**OPT-HL**) and those offered to both (**OPT-SL/HL**). All candidates are required to study two options. All candidates must also carry out **practical work** and must participate in **the group 4 project**. In the guide below, we have indicated where the relevant material can be found: SB1 for Senior Biology 1 and SB2 for Senior Biology 2.

| Topic | See workbook |
|---|---|
| CORE: (All students) | |
| 1 Statistical analysis | |
| 1.1 Mean and SD, t-test, correlation. | SB1 Skills in Biology |
| • For this CORE topic also see the TRC: Spreadsheets and Statistics | |
| 2 Cells | |
| 2.1 Cell theory. Cell and organelle sizes. Surface area to volume ratio. Emergent properties. Cell specialization and differentiation. Stem cells. | SB1 Cell Structure, Processes in Cells |
| 2.2 Prokaryotic cells: ultrastructure & function. | SB1 Cell Structure |
| 2.3 Eukaryotic cells: ultrastructure & function. Prokaryotic vs eukaryotic cells. Plant vs animal cells. Extracellular components. | SB1 Cell Structure, Processes in Cells |
| 2.4 Membrane structure. Active and passive transport. Diffusion and osmosis. | SB1 Processes in Cells |
| 2.5 Cell division and the origins of cancer. | SB1 Processes in Cells |
| • For extension on this topic also see the TRC: The Cell Theory | |
| 3 The chemistry of life | |
| 3.1 Elements of life. The properties and importance of water. | SB1 The Chemistry of Life |
| 3.2 Structure and function of carbohydrates, lipids, and proteins. | SB1 The Chemistry of Life |
| 3.3 Nucleotides and the structure of DNA. | SB1 The Chemistry of Life |
| 3.4 Semi-conservative DNA replication. | SB1 Molecular Genetics |
| 3.5 RNA and DNA structure. The genetic code. Transcription. Translation. | SB1 Molecular Genetics |
| 3.6 Enzyme structure and function. | SB1 The Chemistry of Life |
| 3.7 Cellular respiration and ATP production. | SB1 Cellular Energetics |
| 3.8 Biochemistry of photosynthesis. Factors affecting photosynthetic rates. | SB1 Cellular Energetics |
| 4 Genetics | |
| 4.1 Eukaryote chromosomes. Genomes. Gene mutations and consequences. | SB1 Chromosomes & Meiosis |
| 4.2 Meiosis and non-disjunction. Karyotyping and pre-natal diagnosis. | SB1 Chromosomes & Meiosis |
| 4.3 Theoretical genetics: alleles and single gene inheritance, sex linkage, pedigrees. | SB1 Heredity |
| 4.4 Genetic engineering and biotechnology: PCR, gel electrophoresis, DNA profiling. HGP. Transformation. GMOs. Cloning. | SB1 Nucleic Acid Technology |
| • For extension on this topic also see the TRC: Engineering Solutions | |
| 5 Ecology and evolution | |
| 5.1 Ecosystems. Food chains and webs. Trophic levels. Ecological pyramids. The role of decomposers in recycling nutrients. | SB2 Habitat & Distribution, Community Ecology |
| 5.2 The greenhouse effect. The carbon cycle. Precautionary principle. Global warming. | SB2 Ecosystem Ecology & Human Impact |
| 5.3 Factors influencing population size. Population growth. | SB2 Population Ecology |
| 5.4 Genetic variation. Sexual reproduction as a source of variation in species. Evidence for evolution: natural selection. Evolution in response to environmental change. | SB1 Chromosomes & Meiosis, SB1 The Origin & Evolution of Life, Speciation |
| 5.5 Classification. Binomial nomenclature. Features of plant & animal phyla. Keys. | SB2 Classification |
| • For extension on this topic also see the TRC: Classification of Life | |
| 6 Human health and physiology | |
| 6.1 Role of enzymes in digestion. Structure and function of the digestive system. | SB2 Eating to Live |
| 6.2 Structure and function of the heart. The control of heart activity. Blood & vessels. | SB2 Life Blood |

| Topic | See workbook |
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| 6.3 Pathogens and their transmission. Antibiotics. Role of skin as a barrier to infection. Role of phagocytic leukocytes. Antigens & antibody production. HIV/AIDS. | SB2 Defending Against Disease |
| 6.4 Gas exchange. Ventilation systems. Control of breathing. | SB2 Breath of Life |
| 6.5 Principles of homeostasis. Control of body temperature and blood glucose. Diabetes. Role of the nervous and endocrine systems in homeostasis. | SB2 Keeping in Balance, Responding to the Environment |
| 6.6 Human reproduction and the role of hormones. Reproductive technologies and ethical issues. | SB2 The Next Generation |
| COMPULSORY: AHL Topics (HL students only) | |
| 7 Nucleic acids and proteins | |
| 7.1 DNA structure, exons & introns (junk DNA) | SB1 Molecular Genetics |
| 7.2 DNA replication, including the role of enzymes and Okazaki fragments. | SB1 Molecular Genetics |
| 7.3 DNA alignment, transcription. The removal of introns to form mature mRNA. | SB1 Molecular Genetics |
| 7.4 The structure of tRNA and ribosomes. The process of translation. Peptide bonds. | SB1 Molecular Genetics, The Chemistry of Life |
| 7.5 Protein structure and function. | SB1 The Chemistry of Life |
| 7.6 Enzymes: induced fit model. Inhibition. Allostery in the control of metabolism. | SB1 The Chemistry of Life |
| • For extension on this topic see the TRC: The Meselson-Stahl Experiment | |
| 8 Cell respiration and photosynthesis | |
| 8.1 Structure and function of mitochondria. Biochemistry of cellular respiration. | SB1 Cellular Energetics |
| 8.2 Chloroplasts, the biochemistry and control of photosynthesis, chemiosmosis. | SB1 Cellular Energetics |
| 9 Plant science | |
| 9.1 Structure and growth of a dicot plant. Function and distribution of tissues in leaves. Dicots vs monocots. Plant modifications. Auxins. | SB2 Plant Structure & Growth Responses |
| 9.2 Support in terrestrial plants. Transport in angiosperms: ion movement through soil, active ion uptake by roots, transpiration, translocation. Abscisic acid. Xerophytes. | SB2 Plant Support & Transport |
| 9.3 Dicot flowers. Pollination and fertilization. Seeds: structure, germination, dispersal. Flowering and phytochrome. | SB2 Plant Reproduction |
| 10 Genetics | |
| 10.1 Meiosis, and the process of crossing over. Mendel's law of independent assortment. | SB1 Chromosomes & Meiosis |
| 10.2 Dihybrid crosses. Types of chromosomes. | SB1 Heredity |
| 10.3 Polygenic inheritance. | SB1 Heredity |
| • For extension on this topic also see the TRC: Chromosome Mapping | |
| 11 Human health and physiology | |
| 11.1 Blood clotting. Clonal selection. Acquired immunity. Antibodies and monoclonal antibodies. Vaccination. | SB2 Defending Against Disease |
| 11.2 Nerves, muscles, bones and movement. Joints. Skeletal muscle and contraction. | SB2 Muscles & Movement |
| 11.3 Excretion. Structure and function of the human kidney. Urine production. Diabetes. | SB2 Regulating Fluids and Removing Wastes |
| 11.4 Testis and ovarian structure. Spermatogenesis and oogenesis. Fertilization and embryonic development. The placenta. Birth. Role of hormones. | SB2 The Next Generation |



International Baccalaureate Course *continued*

Topic **See workbook**

OPTIONS: **OPT - SL** (*SL students only*)

A Human nutrition and health

- A.1 Diet and malnutrition. Deficiency & supplements. PKU.
 A.2 Energy content of food types. BMI. Obesity and anorexia. Appetite control.
 A.3 Special diet issues; breastfeeding vs bottle-feeding, type II diabetes, cholesterol.

➊ *Provided as a separate complete unit on the IB OPTIONS CD-ROM*

B Physiology of exercise

- B.1 Locomotion in animals. Roles of nerves, muscles, and bones in movement. Joints. Skeletal muscle and contraction.
 B.2 Training and the pulmonary system.
 B.3 Training and the cardiovascular system.
 B.4 Respiration and exercise intensity. Roles of myoglobin and adrenaline. Oxygen debt and lactate in muscle fatigue.
 B.5 Exercise induced injuries and treatment.

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C Cells and energy

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|---|-----|-----------------------|
| C.1 Protein structure and function. Fibrous and globular proteins. | SB1 | The Chemistry of Life |
| C.2 Enzymes: induced fit model. Inhibition. Allostery in the control of metabolism. | SB1 | The Chemistry of Life |
| C.3 Biochemistry of cellular respiration. | SB1 | Cellular Energetics |
| C.4 The biochemistry of photosynthesis including chemiosmosis. Action and absorption spectra. Limiting factors. | SB1 | Cellular Energetics |

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OPTIONS: **OPT - SL/HL** (*SL and HL students*)

D Evolution

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|---|-----|-----------------------------------|
| D.1 Prebiotic experiments. Comets. Protobionts and prokaryotes. Endosymbiotic theory. | SB1 | The Origin & Evolution of Life |
| D.2 Species, gene pools, speciation. Types and pace of evolution. Transient vs balanced polymorphism. | SB1 | Speciation, Patterns of Evolution |
| D.3 Fossil dating. Primate features. Hominid features. Diet and brain size correlation. Genetic and cultural evolution. | ➍ | The Evolution of Humans (TRC) |

D.4-D.5 is extension for HL only

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|---|-----|----------------------------------|
| D.4 The Hardy-Weinberg principle. | SB1 | Speciation |
| D.5 Biochemical evidence for evolution. Biochemical variations indicating phylogenetic relationships. Classification. Cladistics and cladograms | SB1 | The Origin and Evolution of Life |
| | SB2 | Classification |

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E Neurobiology and behavior

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| E.1 Stimuli, responses and reflexes in the context of animal behavior. Animal responses and natural selection. | SB2 | Nerves, Muscles & Movement, Animal Behavior |
| E.2 Sensory receptors. Structure and function of the human eye and ear. | SB2 | Nerves, Muscles & Movement |
| E.3 Innate vs learned behavior and its role in survival. Learned behavior and birdsong. | SB2 | Animal Behavior |
| E.4 Presynaptic neurons at synapses. Examples of excitatory and inhibitory psychoactive drugs. Effects of drugs on synaptic transmission. Causes of addiction. | SB2 | Aspects covered in Nerves, Muscles & Movement |

E.5-E.6 is extension for HL only

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|---|-----|---|
| E.5 Structure and function of the human brain. ANS control. Pupil reflex and its use in testing for death. Hormones as painkillers. | SB2 | Aspects covered in Nerves, Muscles & Movement |
| E.6 Social behavior and organization. The role of altruism in sociality. Foraging behavior. Mate selection. Rhythmic behavior. | SB2 | Animal Behavior |

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Topic **See workbook**

F Microbes and Biotechnology

- F.1 Classification. Diversity of Archaea and Eubacteria. Diversity of viruses. Diversity of microscopic eukaryotes.
 F.2 Roles of microbes in ecosystems. Details of the nitrogen cycle including the role of bacteria. Sewage treatment. Biofuels.
 F.3 Reverse transcription. Somatic vs germline, gene therapy. Viral vectors.
 F.4 Microbes involved in food production of beer, wine, bread, and soy sauce. Food preservation. Food poisoning.

F.5-F.6 is extension for HL only

- F.5 Metabolism of microbes. Modes of nutrition. Cyanobacterium. Bioremediation.
 F.6 Pathogens and disease: influenza virus, malaria, bacterial infections. Controlling microbes. Epidemiology. Prion hypothesis.

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G Ecology and conservation

- G.1 Factors affecting plant and animal distribution. Sampling. Ecological niche and the competitive exclusion principle. Species interactions. Measuring biomass.
 G.2 Trophic levels. Ecological pyramids. Primary vs secondary succession. Biome vs biosphere. Plant productivity (includes calculating gross and net production, and biomass).
 G.3 Conservation of biodiversity. Diversity index. Human impact on ecosystems: alien species. Biological control. Effect of CFCs on ozone layer. UV radiation absorption.

G.4-G.5 is extension for HL only

- G.4 Monitoring environmental change. Biodiversity. Endangered species. Conservation Strategies. Extinction.
 G.5 *r*-strategies and *K*-strategies. Mark-and-recapture sampling. Fisheries conservation.

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OPTION: **OPT - HL** (*HL students only*)

H Further human physiology

- H.1 Hormones and their modes of action. Hypothalamus and pituitary gland. Control of ADH secretion.
 H.2 Digestion and digestive juices. Stomach ulcers and stomach cancers. Role of bile.
 H.3 Structure of villi. Absorption of nutrients and transport of digested food.
 H.4 The structure and function of the liver (including role in nutrient processing and detoxification). Liver damage from alcohol.
 H.5 The cardiac cycle and control of heart rhythm. Atherosclerosis, coronary thrombosis and coronary heart disease.
 H.6 Gas exchange: oxygen dissociation curves and the Bohr shift. Ventilation rate and exercise. Breathing at high altitude. Causes and effects of asthma.

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Practical Work (*All students*)

Practical work consists of short and long term investigations, and an interdisciplinary project (The Group 4 project). Also see the "Guide to Practical Work" on the last page of this introductory section.

Short and long term investigations

Investigations should reflect the breadth and depth of the subjects taught at each level, and include a spread of content material from the core, options, and AHL material, where relevant.

The Group 4 project

All candidates must participate in the group 4 project. In this project it is intended that students analyze a topic or problem suitable for investigation in each of the science disciplines offered by the school (not just in biology). This project emphasizes the processes involved in scientific investigations rather than the products of an investigation.