

Topic 6: Human physiology Lesson Plans

Resources: Kognity & IB Biology DP Second Edition (Hodder, 2014)

6.1 Lessons Plans - Weeks 1 - 3 (Sept - mid Oct, 2020)

* Touched base with students about IA progress and updated details about their topic and current state.

* Asked students how much time they wanted to spend in class on IA. Students said they would prefer to use class time to finish course content.

* Asked students how they would prefer to learn. Student request was for PPTs and handouts instead of using Kognity as the main focus during lessons and for HW.

Students did agree to Kognity Exam-Style Questions.

* 6.1 - 6.6 Kognity Exam-Style Questions assigned - due 1 week before the end of the unit (this date was changed to late November after instituting regular weekly exam-style test practice).

6.1 Digestion and absorption Essential idea: The structure of the wall of the small intestine allows it to move, digest and absorb food.

6.1 Nature of science:

Use models as representations of the real world—dialysis tubing can be used to model absorption in the intestine. (1.10)

6.1 Understandings:

* The contraction of circular and longitudinal muscle of the small intestine mixes the food with enzymes and moves it along the gut.

* The pancreas secretes enzymes into the lumen of the small intestine.

* Enzymes digest most macromolecules in food into monomers in the small intestine.

* Villi increase the surface area of epithelium over which absorption is carried out.

* Villi absorb monomers formed by digestion as well as mineral ions and vitamins.

* Different methods of membrane transport are required to absorb different nutrients.

6.1 Applications and skills:

* Application: Processes occurring in the small intestine that result in the digestion of starch and transport of the products of digestion to the liver.

* Application: Use of dialysis tubing to model absorption of digested food in the intestine.

6.1 Utilization:

* Some hydrolytic enzymes have economic importance, for example amylase in production of sugars from starch and in the brewing of beer.

6.1 Syllabus and cross-curricular links:

Topic 2.1 Molecules to metabolism

Topic 2.5 Enzymes

6.1 Digestion and absorption

* Skill: Production of an annotated diagram of the digestive system.

* Skill: Identification of tissue layers in transverse sections of the small intestine viewed with a microscope or in a micrograph.

6.1 Guidance:

* Students should know that amylase, lipase and an endopeptidase are secreted by the pancreas. The name trypsin and the method used to activate it are not required.

* Students should know that starch, glycogen, lipids and nucleic acids are digested into monomers and that cellulose remains undigested.

* Tissue layers should include longitudinal and circular muscles, mucosa and epithelium.

Videos:

- 6.1-1 Through the Esophagus The Function of Peristalsis.mp4
- 6.1-2 How your digestive system works.mp4
- 6.1-3 Digestion By Enzymes - Organic Chemistry.mp4
- 6.1-4 absorption by villi.mp4

Handouts:

- Biology12_U4_L1_HandOut2VocabularySTUDENT.pdf
- Biology12_U4_L1_Handout4Digestive Worksheet1.pdf
- Biology12_U4_L7_Handout_Digestive_Enzymes.pdf
- Digestive System Worksheet 2.pdf
- Digestive System Cloze - Creative assignment.pdf

* These handouts were uploaded first as .docx, but students said that they could not read them. Then they were emailed, then uploaded as .pdf, and finally printed. Still, students only completed one of the handouts as a class after I insisted that they finish using class time. Only one student submitted anything else - a short paragraph response to the 2 page creative assignment. Decision to try assigning Kognity HW in upcoming weeks.

* Also aware that students were welcome to decide their own priorities and were told that their IA work is paramount given that it may be the basis by which their entire final mark is determined if this year's exams get cancelled like last year due to the corona virus.

PPTs:

- Biology12_U4_L1_PPTMouthtoStomachSTUDENT.pptx
- Biology12_U4_L3_PPTSmall_Intestine_Pancreas_and_Bile - Student.pptx
- Biology12_U4_L4_PPTLarge Intestine -student.pptx
- Biology12_U4_L5_PPTLiver_and_Gallbladder student.pptx

These slides involve blanks giving students the chance to speak up, and actively fill in in response during the teacher presentation of

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- Biology12_U4_L5_PPTLiver_and_Gallbladder.pptx

Additional resources:

<https://i-biology.net/ibd/bio/06-human-health-physiology/digestion/>

* Students agreed to begin taking practice exams by topic once a week during our Thursday (1 hr 20 min) period.

These exams are focused on questions from 1 topic, so that in future weeks students will have a clear sense of their areas of strength and weakness and will be able to

choose which topic(s) they would like to focus on and improve (through extra practice questions, further review classes and retests).

* Students also agreed to make upcoming Tuesday classes the day for HL studies, giving SL students a chance to do extra work on their other classes through self-study.

* Student performance on IB Exam-Style (past paper) Topic 1 questions for which they should have already learned previously, and for which they had a full week to prepare, was quite poor (12% class average).

The Topic 1 - Cell Biology Test was created using topic 1 questions from the IB Question Bank (<https://questionbank.ibo.org/>), but I noticed that many questions were not from topic 1. To calculate the student topic 1 mark, I only looked at the questions that were actually covered in topic 1.

Next, the topic 1 test prepared was 20 pages, but students only finished the first several pages in the time given, so I only marked those pages. The mark was calculated from the first relevant questions adding up to 17 marks (student total/17 x 6 = total/100).

* Decision: Identify relevant questions before handing students upcoming IB Exam-Style (past paper) tests (the IB Question Bank questions are not properly sorted by topic), and be sure to keep tests to a reasonable size: 17 marks, 20 marks, 25 marks max.

* Topic 1 Tests were returned to students with corrections provided.

Week 2 No classes (October National Holiday)

Final chance to submit 6.1 Digestion HW, ask questions and cover concepts.
Digestion Review Worksheet 1.pdf

6.1 Quiz /9 about the organs and enzymes involved in the digestion system.
Quiz results ranged from 0% to 100%.

* Student performance on IB Exam-Style (past paper) Topic 2 questions for which they should have already learned previously and for which they had a full week to prepare were quite poor, but better than last time (35% class average, up from 12%).

* Topic 2 Tests were returned to students with corrections and page number references relevant to written answers provided.

* Students invited to submit a reflection progress, along with SMART goals. No student submitted any written reflection, but did share some thoughts and ideas during class time.

* 6.1 - 6.2 Kognity HW Questions assigned.

6.2 Lessons Plans - Week 4 (3rd week of Oct, 2020)

Topic 6: Human physiology

6.2 Essential idea: The blood system continuously transports substances to cells and simultaneously collects waste products.

6.2 The blood system Nature of science: Theories are regarded as uncertain—William Harvey overturned theories developed by the ancient Greek philosopher Galen on movement of blood in the body. (1.9)

6.2 Understandings:

- * Arteries convey blood at high pressure from the ventricles to the tissues of the body.
- * Arteries have muscle cells and elastic fibres in their walls.
- * The muscle and elastic fibres assist in maintaining blood pressure between pump cycles.
- * Blood flows through tissues in capillaries. Capillaries have permeable walls that allow exchange of materials between cells in the tissue and the blood in the capillary.
- * Veins collect blood at low pressure from the tissues of the body and return it to the atria of the heart.
- * Valves in veins and the heart ensure circulation of blood by preventing backflow.
- * There is a separate circulation for the lungs.
- * The heart beat is initiated by a group of specialized muscle cells in the right atrium called the sinoatrial node.
- * The sinoatrial node acts as a pacemaker.
- * The sinoatrial node sends out an electrical signal that stimulates contraction as it is propagated through the walls of the atria and then the walls of the ventricles.
- * The heart rate can be increased or decreased by impulses brought to the heart through two nerves from the medulla of the brain.
- * Epinephrine increases the heart rate to prepare for vigorous physical activity.

6.2 Theory of knowledge:

- * Our current understanding is that emotions are the product of activity in the brain rather than the heart. Is knowledge based on science more valid than knowledge based on intuition?

Utilization:

- * Understanding of the structure of the cardiovascular system has allowed the development of heart surgery.

6.2 Syllabus and cross-curricular links:

Topic 2.2 Water

Topic 2.3 Carbohydrates and lipids

Topic 6.4 Gas exchange

Topic 6.6 Hormones, homeostasis and reproduction

Aims:

- * Aim 6: A heart dissection is suggested as a means of studying heart structure.
- * Aim 8: The social implications of coronary heart disease could be discussed.

6.2 The blood system

6.2 Applications and skills:

- * Application: William Harvey's discovery of the circulation of the blood with the heart acting as the pump.
- * Application: Pressure changes in the left atrium, left ventricle and aorta during the cardiac cycle.
- * Application: Causes and consequences of occlusion of the coronary arteries.

* Skill: Identification of blood vessels as arteries, capillaries or veins from the structure of their walls.

* Skill: Recognition of the chambers and valves of the heart and the blood vessels connected to it in dissected hearts or in diagrams of heart structure.

Videos:

- 6.2-1 Circulation.mp4
- 6.2-2 Blood flow in a normal carotid artery bifurcation.mp4
- 6.2-3 Systemic and Pulmonary Circulation.mp4
- 6.2-4 The Heart and the Systemic Circuit.mp4
- 6.2-5 Heart beating outside the human body.mp4
- 6.2-6 Conducting System Of The Heart.mp4
- 6.2-7 Anatomy and Physiology Cardiac Control Center in Medulla Oblongata.mp4
- 6.2-8 What is atherosclerosis.mp4

PPTs:

- Biology12_U5_L1_PPT1Blood VesselsSTUDENT.pptx
- Biology12_U5_L2_PPTHeartSTUDENT.pptx
- Biology12_U5_L3_PPTBlood CompositionSTUDENT.pptx
- Biology12_U5_L4_PPTCardiovascular Diseases STUDENT.pptx

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- Biology12_U5_L1_PPT1Blood Vessels.pptx
- Biology12_U5_L2_PPTHeart.pptx
- Biology12_U5_L3_PPTBlood Composition.pptx
- Biology12_U5_L4_PPTCardiovascular Diseases.pptx

Additional resources:

- <https://i-biology.net/ahl/07-nucleic-acids-and-proteins/>
- blood.pdf
- the circulatory system.pdf

* Student performance on IB Exam-Style (past paper) Topic 3 questions for which they should have already learned previously, and for which they had a full week to prepare, was not as good as last time (18%). Tests were returned to students with corrections and page number references for written answers.

* Students were introduced to new methods of learning for upcoming weeks:

- Student Presentations, which will be used during 6.3 & 6.4
- Spider-Web Discussion, which will be used during 6.5
- Flipped Classroom, which will be used to study 6.6

* Students will be welcome choose their preferred method of continuing studies after that point to explore further topics.

*6.1 & 6.2 Kognity HW was only completed by two students, and the student who achieved 100% in quiz is also the one who fully completed the Kognity HW well.

* 6.2 - 6.3 Kognity HW Questions assigned.

6.3 Lessons Plans - Week 5 (end of Oct, 2020)

* Student Presentations

Topic 6: Human physiology

6.3 Essential idea: The human body has structures and processes that resist the continuous threat of invasion by pathogens.

6.3 Defence against infectious disease Nature of science: Risks associated with scientific research—Florey and Chain’s tests on the safety of penicillin would not be compliant with current protocol on testing. (4.8) 6.3 Understandings:

- * The skin and mucous membranes form a primary defence against pathogens that cause infectious disease.
- * Cuts in the skin are sealed by blood clotting.
- * Clotting factors are released from platelets.
- * The cascade results in the rapid conversion of fibrinogen to fibrin by thrombin.
- * Ingestion of pathogens by phagocytic white blood cells gives non-specific immunity to diseases.
- * Production of antibodies by lymphocytes in response to particular pathogens gives specific immunity.
- * Antibiotics block processes that occur in prokaryotic cells but not in eukaryotic cells.
- * Viruses lack a metabolism and cannot therefore be treated with antibiotics. Some strains of bacteria have evolved with genes that confer resistance to antibiotics and some strains of bacteria have multiple resistance.

6.3 Applications and skills:

- * Application: Causes and consequences of blood clot formation in coronary arteries.
- * Application: Florey and Chain’s experiments to test penicillin on bacterial infections in mice.
- * Application: Effects of HIV on the immune system and methods of transmission.

6.3 International-mindedness:

- * The spread and containment of diseases such as bird flu require international coordination and communication.

6.3 Utilization:

- * An understanding of immunity has led to the development of vaccinations.

6.3 Syllabus and cross-curricular links:

Topic 5.2 Natural selection

Chemistry Topic D2 Aspirin and penicillin

6.3 Aims:

- * Aim 8: The social as well as the economic benefits of the control of bacterial diseases around the world should be stressed.
- * Aim 9: Science has limited means in the fight against pathogens, as shown by the spread of new diseases and antibiotic-resistant bacteria.

6.3 Defence against infectious disease

Guidance:

- * Diagrams of skin are not required.
- * Subgroups of phagocyte and lymphocyte are not required but students should be aware that some lymphocytes act as memory cells and can quickly reproduce to form a clone of plasma cells if a pathogen carrying a specific antigen is re-encountered.

* The effects of HIV on the immune system should be limited to a reduction in the number of active lymphocytes and a loss of the ability to produce antibodies, leading to the development of AIDS.

Students presenting chose to make the teaching PPTs available to them as well as the rest of the class:

- Biology12_U7_L1_PPTImmunity.pptx
- Biology12_U7_L1_PPTImmunity 2.pptx
- Biology12_U7_L1_PPTLymphatic System.pptx

Videos:

- 6.3-1 Platelet Activation and Factors for Clot Formation.mp4
- 6.3-2 Coronary Artery Disease (CAD) Animation - MADE EASY.mp4
- 6.3-3 Acute Coronary Syndrome (ACS) Pathology.mp4
- 6.3-4 Phagocytosis.mp4
- 6.3-5 Immune System - Fighting Infection by Clonal Selection.mp4
- 6.3-6 Phagocytosis Under the microscope.mp4

6.3-6 The-Drug-Discovery-Process.png
Respiratory Epithelium - Cilia.png

Additional resources:

- <https://i-biology.net/ibdpbio/06-human-health-physiology/defense-against-infectious-disease/>
- <https://natureofscienceib.wordpress.com/2015/11/18/6-3-ethics-and-penicillin/>
- 6.3.NOS.pptx
- the immune system.pdf

* Student performance on IB Exam-Style (past paper) Topic 4 Test was the best so far (55%), but this material and these questions are easier than those found in other sections.

* Topic 4 Tests were returned to students with corrections and page number references relevant to written answers provided.

* 6.2 - 6.3 Kognity HW Questions Checked

* 6.2 & 6.3 Quiz.docx, an 8 mark test covering different topics on Friday Quiz results were interesting - again, the results ranged from 0% to 100%, again the student who achieved 100% also completed the Kognity HW well.

* 6.4 Kognity Assignment Assigned

6.4 Lessons Plans - Week 6 (1st week of Nov, 2020)

* Student Presentations

Topic 6: Human physiology

6.4 Essential idea: The lungs are actively ventilated to ensure that gas exchange can occur passively.

6.4 Gas exchange Nature of science: Obtain evidence for theories—epidemiological studies have contributed to our understanding of the causes of lung cancer. (1.8)

6.4 Understandings:

- * Ventilation maintains concentration gradients of oxygen and carbon dioxide between air in alveoli and blood flowing in adjacent capillaries.
- * Type I pneumocytes are extremely thin alveolar cells that are adapted to carry out gas exchange.
- * Type II pneumocytes secrete a solution containing surfactant that creates a moist surface inside the alveoli to prevent the sides of the alveolus adhering to each other by reducing surface tension.
- * Air is carried to the lungs in the trachea and bronchi and then to the alveoli in bronchioles.
- * Muscle contractions cause the pressure changes inside the thorax that force air in and out of the lungs to ventilate them.
- * Different muscles are required for inspiration and expiration because muscles only do work when they contract. Applications and skills:
 - * Application: Causes and consequences of lung cancer.
 - * Application: Causes and consequences of emphysema.
 - * Application: External and internal intercostal muscles, and diaphragm and abdominal muscles as examples of antagonistic muscle action.
 - * Skill: Monitoring of ventilation in humans at rest and after mild and vigorous exercise. (Practical 6

6.4 Syllabus and cross-curricular links: Biology Topic 1.4 Membrane transport Topic 1.6 Cell division Topic 6.2 The blood system Physics Topic 3.2 Modelling a gas

Aims:

- * Aim 8: The social consequences of lung cancer and emphysema could be discussed.

6.4 Gas exchange

Guidance:

- * Ventilation can either be monitored by simple observation and simple apparatus or by data logging with a spirometer or chest belt and pressure meter. Ventilation rate and tidal volume should be measured, but the terms vital capacity and residual volume are not expected.
- * Students should be able to draw a diagram to show the structure of an alveolus and an adjacent capillary.

Videos:

- 6.4-1 Alveoli_ Gas Exchange.mp4
- 6.4-2 Lung Model.mp4
- 6.4-3 The Respiratory System.mp4
- 6.4-4 Mechanics of breathing v3 0.mp4
- 6.4-5 Explain mechanism of ventilation.mp4
- 6.4-6 Spirometer.mp4
- 6.4-7 Dry Spirometer.mp4

- 6.4-8 ISB SCIENCE Project - Lung Capacity.mp4
- 6.4-9 Spirometer - Tech Tips with Vernier.mp4
- 6.4-10 Spirometer Part 1.mp4
- 6.4-11 NeuLog Spirometer Demonstration - Lung Capacity.mp4
- 6.4-12 Lungs in Motion - Emphysema.mp4

Students presenting chose to make the teaching PPTs available to them as well as the rest of the class:

- Biology12_U6_L1_PPTRespiration.pptx
- Biology12_U6_L3_PPTRespiration 2.pptx
- Biology12_U6_L4_PPT_Gas Exchange.pptx

Additional resource:

<https://i-biology.net/ibd/bio/06-human-health-physiology/03-gas-exchange/>

- * 6.4 Kognity Assignment Review
- * IB Exam-Style (past paper) Topic 5 Test
- * 6.5 Kognity Assignment Assigned

6.5 Lessons Plans - Week 7 (2nd week of Nov, 2020)

- * Spider-Web Discussion

Topic 6: Human physiology

6.5 Essential idea: Neurons transmit the message, synapses modulate the message.

6.5 Neurons and synapses Nature of science: Cooperation and collaboration between groups of scientists—biologists are contributing to research into memory and learning. (4.3)

6.5 Understandings:

- * Neurons transmit electrical impulses.
- * The myelination of nerve fibres allows for saltatory conduction.
- * Neurons pump sodium and potassium ions across their membranes to generate a resting potential.
- * An action potential consists of depolarization and repolarization of the neuron.
- * Nerve impulses are action potentials propagated along the axons of neurons.
- * Propagation of nerve impulses is the result of local currents that cause each successive part of the axon to reach the threshold potential.
- * Synapses are junctions between neurons and between neurons and receptor or effector cells.
- * When presynaptic neurons are depolarized they release a neurotransmitter into the synapse.
- * A nerve impulse is only initiated if the threshold potential is reached. 6.5

Applications and skills:

- * Application: Secretion and reabsorption of acetylcholine by neurons at synapses.
- * Application: Blocking of synaptic transmission at cholinergic synapses in insects by binding of neonicotinoid pesticides to acetylcholine receptors.

* Skill: Analysis of oscilloscope traces showing resting potentials and action potentials.

6.5 Guidance:

* The details of structure of different types of neuron are not needed.

* Only chemical synapses are required, not electrical, and they can simply be referred to as synapses.

6.5 Utilization:

* An understanding of the workings of neurotransmitters and synapses has led to the development of numerous pharmaceuticals for the treatment of mental disorders.

6.5 Syllabus and cross-curricular links:

Topic 1.4 Membrane transport

Chemistry Topic C6 Electrochemistry, rechargeable batteries and fuel cells

Psychology Core: Biological level of analysis

6.5 Aims:

* Aim 8: The social effects of the abuse of psychoactive drugs could be considered, as could the use of the neurotoxin Botox for cosmetic treatments.

Additional resource: <https://i-biology.net/ibdpbio/06-human-health-physiology/nerves-hormones-homeostasis/>

PPTs:

- Biology12_U9_L1_PPTNeurons.pptx
- Biology12_U9_L2_PPTNerve Impulse.pptx
- Biology12_U9_L3_PPTNerve Synapse.pptx
- Biology12_U9_L6_PPTCNS.pptx
- Biology12_U9_L8_PPTPNS.pptx

* 6.5 Kognity Assignment Review

* 6.6 Kognity Assignment Assigned

* Students may request a Topic 1-5 Re-Test IF they have finished the corrections on their last test (they are expected to gather appropriate information from the reference pages - their effort will also be accepted if they gather the information from another source, such as a classmate or internet search etc.).

6.6 Lessons Plans - Week 8

* Flipped Classroom

Topic 6: Human physiology

6.6 Essential idea: Hormones are used when signals need to be widely distributed.

6.6 Hormones, homeostasis and reproduction

Nature of science:

Developments in scientific research follow improvements in apparatus—William Harvey was hampered in his observational research into reproduction by lack of equipment. The microscope was invented 17 years after his death. (1.8)

Understandings:

* Insulin and glucagon are secreted by β and α cells of the pancreas respectively to control blood glucose concentration.

- * Thyroxin is secreted by the thyroid gland to regulate the metabolic rate and help control body temperature.
- * Leptin is secreted by cells in adipose tissue and acts on the hypothalamus of the brain to inhibit appetite.
- * Melatonin is secreted by the pineal gland to control circadian rhythms.
- * A gene on the Y chromosome causes embryonic gonads to develop as testes and secrete testosterone.
- * Testosterone causes pre-natal development of male genitalia and both sperm production and development of male secondary sexual characteristics during puberty.
- * Estrogen and progesterone cause pre-natal development of female reproductive organs and female secondary sexual characteristics during puberty.
- * The menstrual cycle is controlled by negative and positive feedback mechanisms involving ovarian and pituitary hormones.

Applications and skills:

- * Application: Causes and treatment of Type I and Type II diabetes.
- * Application: Testing of leptin on patients with clinical obesity and reasons for the failure to control the disease.

6.6 Utilization:

- * Hormones are used in a variety of therapies such as replacement therapies.

Syllabus and cross-curricular links:

Topic 3.2 Chromosomes

Topic 3.3 Meiosis

Topic 10.1 Meiosis

Psychology

Core: Biological level of analysis

6.6 Aims:

- * Aim 8: Scientists are aware that the drugs women take in fertility treatment pose potential risks to health. Should scientific knowledge override compassionate considerations in treating infertile couples?

6.6 Hormones, homeostasis and reproduction

- * Application: Causes of jet lag and use of melatonin to alleviate it.
- * Application: The use in IVF of drugs to suspend the normal secretion of hormones, followed by the use of artificial doses of hormones to induce superovulation and establish a pregnancy.
- * Application: William Harvey's investigation of sexual reproduction in deer. * Skill: Annotate diagrams of the male and female reproductive system to show names of structures and their functions.

6.6 Guidance:

- * The roles of FSH, LH, estrogen and progesterone in the menstrual cycle are expected.
- * William Harvey failed to solve the mystery of sexual reproduction because effective microscopes were not available when he was working, so fusion of gametes and subsequent embryo development remained undiscovered.

PPTs:

- Biology12_U8_L1_PPTMale_Reproductive_System.pptx
- Biology12_U8_L2_PPTFemale_Reproductive_System.pptx
- Biology12_U8_L3_PPT Ovarian and Uterine Cycles.pptx

- * Topic 6 Unit Test: IB Exam-Style (past paper) Topic 6 Test