

## **Topic 11 (HL) - Animal Physiology: Antibodies & Vaccination, Movement, Kidney & Osmoregulation, Sexual Reproduction -- 8 lessons, 1 or 2x a week**

Resource: IB Biology DP Second Edition - Hodder (Clegg, 2014), pp. 442-497

\* Students requested to no longer use Kognity, to no longer use the .ppts that I have been uploading or to watch videos, and to have more lecture-style classes, and so these lessons will predominantly follow the book, highlighting and focusing on the main points found there. Similar concepts will be highlighted in similar colors.

### **Week 1 Lessons—11.1 Antibody Production and Vaccination**

Essential idea: Immunity is based on recognition of self and destruction of foreign material.

Nature of science:

Consider ethical implications of research—Jenner tested his vaccine for smallpox on himself as well as on a child (Hodder, p. 452). As a result the beneficial vaccine was available soon afterward in contrast with the long process required in clinical trials today. Detail: the book tells us that the boy was fine afterward, he was vaccinated, but does not tell us Jenner's fate. It seems he was also fine afterward. Also consider the ethical implications if he had died and no one could continue his work. (The rule of thumb in first aid is to be sure we stay safe so that we can continue helping others.)

Understandings:

- \* Every organism has unique molecules on the surface of its cells.
- \* Pathogens can be species-specific although others can cross species barriers.
- \* B lymphocytes are activated by T lymphocytes in mammals.
- \* Activated B cells multiply to form clones of plasma cells and memory cells.
- \* Plasma cells secrete antibodies.
- \* Antibodies aid the destruction of pathogens.
- \* White cells release histamine in response to allergens.
- \* Histamines cause allergic symptoms.
- \* Immunity depends upon the persistence of memory cells.
- \* Vaccines contain antigens that trigger immunity but do not cause the disease.
- \* Fusion of a tumour cell with an antibody-producing plasma cell creates a hybridoma cell.
- \* Monoclonal antibodies are produced by hybridoma cells.

International-mindedness:

- \* The World Health Organization initiated the campaign for the global eradication of smallpox in 1967. The campaign was deemed a success in 1977, only 10 years later.

Added TOK Question: Why might some bacteria and viruses manage to continue to survive inside our body? (Mutation so as not to carry the proteins associated with their detection meaning that our body cannot recognize them as foreign and destroy them).

The experiment about antibody formation (Hodder, p. 454) is similar to one student's IA about bacteria and this point was highlighted.

Utilization:

- \* Human vaccines are often produced using the immune responses of other animals.

Syllabus and cross-curricular links:

Biology Topic 6.3 Defence against infectious disease

Aims:

- \* Aim 7: Use of databases to analyse epidemiological data.

Topic 11: Animal physiology

Applications and skills:

- \* Application: Smallpox was the first infectious disease of humans to have been eradicated by vaccination.
- \* Application: Monoclonal antibodies to HCG are used in pregnancy test kits.
- \* Application: Antigens on the surface of red blood cells stimulate antibody production in a person with a different blood group.
- \* Skill: Analysis of epidemiological data related to vaccination programmes.

Guidance:

- \* Limit the immune response to mammals.

The application in pregnancy testing kits (to tell when the results are complete) was also an interesting application of this knowledge (Hodder, p. 455).

Analogies made to how wars are fought and reference made to an immune system drama that my students previously conducted. Further materials about that activity can be found at my website <https://sirblois.wordpress.com/biology/>.

There was no significant homework assigned beside finishing IAs by December 20<sup>th</sup>.

## **Week 2 Lessons—11.2 Movement**

Nature of science: Developments in scientific research follow improvements in apparatus—fluorescent calcium ions have been used to study the cyclic interactions in muscle contraction.

Essential idea: The roles of the musculoskeletal system are movement, support and protection.

Understandings:

- \* Bones and exoskeletons provide anchorage for muscles and act as levers.
- \* Synovial joints allow certain movements but not others.
- \* Movement of the body requires muscles to work in antagonistic pairs.
- \* Skeletal muscle fibres are multinucleate and contain specialized endoplasmic reticulum.
- \* Muscle fibres contain many myofibrils.
- \* Each myofibril is made up of contractile sarcomeres.
- \* The contraction of the skeletal muscle is achieved by the sliding of actin and myosin filaments.
- \* ATP hydrolysis and cross bridge formation are necessary for the filaments to slide.

\* Calcium ions and the proteins tropomyosin and troponin control muscle contractions.

Aims:

- \* Aim 7: Use of grip strength data loggers to assess muscle fatigue.
- \* Aim 7: Use of animations to visualize contraction.

Applications and skills:

- \* Application: Antagonistic pairs of muscles in an insect leg.
- \* Skill: Annotation of a diagram of the human elbow.
- \* Skill: Drawing labelled diagrams of the structure of a sarcomere. \* Skill: Analysis of electron micrographs to find the state of contraction of muscle fibres.

Guidance:

- \* Elbow diagram should include cartilage, synovial fluid, joint capsule, named bones and named antagonistic muscles.
- \* Drawing labelled diagrams of the structure of a sarcomere should include Z lines, actin filaments, myosin filaments with heads, and the resultant light and dark bands.
- \* Measurement of the length of sarcomeres will require calibration of the eyepiece scale of the microscope.

**circumduction** related to the known word *circumference* (Hodder, p. 459)

Activities:

“Draw and annotate a diagram of the human elbow, showing joint structure, named bones and antagonistic muscles *in situ*, by combining information from Figures 11.12 and 11.13.” (Hodder, p. 458)

“Draw and annotate a diagram of show the structure of a sarcomere; show Z lines, actin filaments, myosin filaments with ‘heads’, and the light and dark bands.” (Hodder, p. 462)

“Identify the approximate state of contraction illustrated in the sketch of the electron micrograph of a myofibril shown in Figure 11.22.” (Hodder, p. 466)

Again, no significant homework assigned beside finishing IAs by December 20<sup>th</sup>.

### **Week 3 Lessons—11.3 Kidneys and Osmoregulation**

Essential idea: All animals excrete nitrogenous waste products and some animals also balance water and solute concentrations.

Nature of science: Curiosity about particular phenomena—investigations were carried out to determine how desert animals prevent water loss in their wastes.

Understandings:

- \* Animals are either osmoregulators or osmoconformers.
- \* The Malpighian tubule system in insects and the kidney carry out osmoregulation and removal of nitrogenous wastes.
- \* The composition of blood in the renal artery is different from that in the renal vein.
- \* The ultrastructure of the glomerulus and Bowman’s capsule facilitate ultrafiltration.

- \* The proximal convoluted tubule selectively reabsorbs useful substances by active transport.
- \* The loop of Henle maintains hypertonic conditions in the medulla.
- \* ADH controls reabsorption of water in the collecting duct. \* The length of the loop of Henle is positively correlated with the need for water conservation in animals.
- \* The type of nitrogenous waste in animals is correlated with evolutionary history and habitat.

*Connection made between the concept of kidney cleaning waste and excretion through the bladder with a previously studied previous exam question about the renal vein containing less toxins than renal arterial blood due to this cleaning function.*

Applications and skills:

- \* Application: Consequences of dehydration and overhydration.
- \* Application: Treatment of kidney failure by hemodialysis or kidney transplant.
- \* Application: Blood cells, glucose, proteins and drugs are detected in urinary tests.
- \* Skill: Drawing and labelling a diagram of the human kidney.
- \* Skill: Annotation of diagrams of the nephron.

Utilization:

- \* The removal of kidney stones by ultra sound treatment.

Guidance:

- \* ADH will be used in preference to vasopressin.
- \* The diagram of the nephron should include glomerulus, Bowman's capsule, proximal convoluted tubule, loop of Henle, distal convoluted tubule; the relationship between the nephron and the collecting duct should be included.

Again, no significant homework assigned beside finishing IAs by December 20<sup>th</sup>.

December “winter-camp” holiday homework will be assigned, however, and students will be expected to make some progress during the winter holiday.

## **Week 4 Lessons—11.4 Sexual reproduction**

Essential idea: Sexual reproduction involves the development and fusion of haploid gametes.

Nature of science: Assessing risks and benefits associated with scientific research—the risks to human male fertility were not adequately assessed before steroids related to progesterone and estrogen were released into the environment as a result of the use of the female contraceptive pill. (4.8)

Understandings:

- \* Spermatogenesis and oogenesis both involve mitosis, cell growth, two divisions of meiosis and differentiation.
- \* Processes in spermatogenesis and oogenesis result in different numbers of gametes with different amounts of cytoplasm.
- \* Fertilization in animals can be internal or external.

- \* Fertilization involves mechanisms that prevent polyspermy. \* Implantation of the blastocyst in the endometrium is essential for the continuation of pregnancy.
- \* HCG stimulates the ovary to secrete progesterone during early pregnancy.
- \* The placenta facilitates the exchange of materials between the mother and fetus.
- \* Estrogen and progesterone are secreted by the placenta once it has formed.
- \* Birth is mediated by positive feedback involving estrogen and oxytocin.

Applications and skills:

- \* Application: The average 38-week pregnancy in humans can be positioned on a graph showing the correlation between animal size and the development of the young at birth for other mammals.
- \* Skill: Annotation of diagrams of seminiferous tubule and ovary to show the stages of gametogenesis.
- \* Skill: Annotation of diagrams of mature sperm and egg to indicate functions.

Guidance: \* Fertilization involves the acrosome reaction, fusion of the plasma membrane of the egg and sperm and the cortical reaction.

Syllabus and cross-curricular links: Biology Topic 3.3 Meiosis Topic 6.6 Hormones, homeostasis and reproduction

Aims: \* Aim 8: Disputes over the responsibility for frozen human embryos.