**Unit 9: Human Physiology**

**Subtopics:**

**6.1 Digestion & Absorption**

**6.2 The Blood System**

**6.3 Defense Against Infectious Disease**

**6.4 Gas Exchange**

**6.5 Neurons & Synapses**

**6.6 Hormones, Homeostasis, and Reproduction**

***Major Understandings, Applications & Skills (Study Guide):***

*Digestion & Absorption (6.1)*

Proficient:

* 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.

Exceeds:

* 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.
* 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.

*The Blood System (6.2)*

Proficient:

* 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.

Exceeds:

* 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.

*Defense Against Infectious Diseases (6.3)*

Proficient:

* The skin and mucous membranes form a primary defense 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.

Exceeds:

* 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.

*Gas Exchange (6.4)*

Proficient:

* 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.

Exceeds:

* 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)

*Neurons & Synapses (6.5)*

Proficient:

* 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.

Exceeds:

* 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.

*Hormones, Metabolism, Homeostasis, and Reproduction (6.6)*

Proficient:

* 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.

Exceeds:

* 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.
* 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.