D1 Human Nutrition

- Essential nutrients have to part of the diet because they cannot be synthesized by the body. These include:
  - Dietary minerals (chemical elements)
  - Vitamins are chemically diverse carbon compounds.
  - Some fatty acids
  - Some amino acids - needed for protein production.
- Malnutrition may be caused by a deficiency, imbalance or excess of nutrients in the diet.
- The hypothalamus controls appetite.
- Hypertension and type II diabetes are more likely if a person is overweight.
- Starvation can cause body tissue to be broken down.

Essential Question(s)

- Do pizza’s contain all the essential nutrients for a healthy body?
- What are the essential nutrients?
- What is the role of vitamins and minerals in the diet?
- What are the effects of malnutrition?
- How can malnutrition involve eating too much, too little, or both?
- How can combustion of food help us to calculate the energy content of the food?

Skills (can you ... ?)

- Know that ascorbic acid (Vit C) is produced by some mammals, but not others.
- Understanding of how phenylketonuria (PKU) caused by a genetic mutation, can be treated by controlling the diet.
- Know how rickets (or osteomalacia) is caused by a lack of Vitamin D or calcium leading to problems in bone mineralization.
- Understand that heart muscle is broken down in anorexia.
- Know how cholesterol in blood can be used as an indicator or coronary heart disease risk.
- Determine the energy content of food by combustion, heating water.
- Use databases to calculate nutritional composition of a daily diet.

**D2 Digestion**

- The structure of cells of the epithelium of the villi, including microvilli
- Exocrine glands secrete to the surface of the body or the lumen of the gut.
- Nervous and hormonal mechanisms control the secretion of digestive juices.
- The volume and content of gastric secretions are controlled by nervous and hormonal mechanisms.
- Acid conditions in the stomach favour some hydrolysis reactions and help to control pathogens in ingested food.
- The structure of cells of the epithelium of the villi, including microvilli and mitochondria, is adapted to the absorption of food.
- The rate of transit of materials through the large intestine is positively correlated with their fibre content.
- Materials not absorbed are egested.

**Essential Questions**

- What do we already know about the structure of lining of the digestive system?
- How does the body (brain) control the functioning of the organs?
- What do we know already about enzymes
- Do your stomach lining, the pancreas and other digestive glands produce digestive juices all the time?
Do these secretions always contain the same amounts of digestive enzymes?

If not, how are these glands controlled?

How does the stomach protect itself from the hydrochloric acid and protein digesting enzymes it contains?

What could happen if a gunshot wound or a bacteria like *H. pylori* damaged the stomach lining?

Skills (can you ... ?)

- Identify exocrine gland cells that secrete digestive juices and villus epithelium cells that absorb digested foods from electron micrographs
- Explain how the reduction of stomach acid secretion by proton pump inhibitor drugs.
- Understand dehydration due to cholera toxin.
- Use the example of *Helicobacter pylori* infection as a cause of stomach ulcers.

D3 The Liver

- The functions of the liver
  - removes toxins from the blood
  - detoxifies toxins - e.g. alcohol.
  - recycles components of red blood cells. (erythrocytes)
  - Iron is carried to bone marrow for production of hemoglobin for new red blood cells.
  - Surplus cholesterol is converted to bile salts.
  - blood is intercepted from the gut.
  - regulates nutrient levels, eg: glucose
  - stores some nutrients; e.g. vit. A & D
- Hepatocytes produce plasma proteins (e.g. fibrinogen) using their endoplasmic reticulum and Golgi apparatus.
- Temporary slides of hepatocytes can be prepared from fresh liver.
- Kupffer cells use phagocytosis to begin recycling of red blood cells.
- Sinusoids carry blood through the liver, they are different in structure to capillaries.
Essential Question(s)

- Liver cells were used as a model eukaryote animal cell in topic 1. How many different types of organelle do they contain.
- Why do liver cells make better cell models than motor neurones?
- What are the functions of rER, Golgi apparatus and lysosomes in cells?
- What is the role of the liver in the body?
- Which systems of the body would be most affected if the liver stops working?
- Hepatocytes and Kupffer cells are two specialised cells in the liver, what special jobs might they have.
- Sinusoids are special channels through which blood flows in the liver, why do they have ‘fenestrated’ walls (with holes)?

Skills (can you ... ?)

- Suggest causes of jaundice, and link them to liver function?
- Explain that liver damage due to infection or alcohol, disrupts the liver’s ability to process bilirubin,
- Say that bilirubin is a waste product of red blood cells break down normally made into bile in the liver.
- Explain the dual blood supply to the liver.
- Describe the differences between sinusoids and capillaries.

D4 The Heart

- Structure of cardiac muscle cells includes branching and intercalated discs.
- This structure aids propagation of stimuli through the heart wall.
- Control of heart beat within the heart.
- Signals from the sinoatrial node that cause contraction of atria cannot pass directly from atria to ventricles.
● There is a delay between the arrival and passing on of a stimulus at the atrioventricular node.
● This delay allows time for atrial systole before the atrio-ventricular valves close in ventricular systole.
● Conducting fibres ensure coordinated contraction of the entire ventricle wall.
● Normal heart sounds are caused by the atrio-ventricular valves and semilunar valves closing & causing changes in blood flow.

**Essential Question(s)**

● What is special about the structure of cardiac muscle?
● The heart is myogenic, it can beat on its own. How does this happen?

● What is the function of the valves in the heart & how do they change blood flow?

**Skills (can you ... ?)**

● Say how artificial pacemakers can regulate the heart rate.
● Suggest how defibrillation can treat life-threatening cardiac conditions.
● Outline the causes and consequences of hypertension and thrombosis.
● Measure and interpret the heart rate under different conditions.
● Interpret systolic and diastolic blood pressure measurements, e.g. 120 / 80 or 12 / 8.
● Map the cardiac cycle to a normal ECG trace.
● Analyse epidemiological data relating to the incidence of coronary heart disease.

**D5 Hormones**

● Endocrine glands secrete hormones directly into the bloodstream.
● Steroid hormones
○ bind to receptor proteins in the cytoplasm of the target cell to
○ form a receptor–hormone complex.
○ which promotes the transcription of specific genes.
● Peptide hormones
○ bind to receptors in the plasma membrane of the target cell.
○ this binding activates a cascade of reactions
○ mediated by a second messenger inside the cell.
● The hypothalamus controls hormone secretion by the anterior and posterior lobes of the pituitary gland.
● Hormones secreted by the pituitary control growth, developmental changes, reproduction and homeostasis.

Essential Question(s)

● How can a chemical released into the blood cause a change in the functioning of another cell
● What different types of hormones are there?
● How can nerves in the hypothalamus control a gland like the pituitary gland?
● Could a neurone make a hormone?

Skills (can you ... ?)

● Say why some athletes take growth hormones to build muscles.
● Outline the control of milk secretion by the hormones oxytocin and prolactin?

D6 Respiratory gases

● Oxygen dissociation curves show the oxygen affinity of hemoglobin.
● The increased release of oxygen by hemoglobin in respiring tissues is explained by the Bohr shift.
● Fetal hemoglobin is different from adult hemoglobin. This allows the transfer of oxygen in the placenta from mother's hemoglobin to fetal hemoglobin.
Carbon dioxide is carried in the blood in three ways:
  ○ in solution
  ○ bound to hemoglobin
  ○ transformed in red blood cells into hydrogencarbonate ions which diffuse into the blood plasma.

Changes in blood pH caused by changes in CO₂ concentration are detected by chemoreceptors.

The respiratory control centre in the medulla oblongata controls the rate of ventilation in response to the amount of CO₂ in the blood. (during exercise!)

**Essential Question(s)**

- What does "partial pressure" represent?
- If the hemoglobin in the lungs attaches to oxygen molecules, how do the muscles take this oxygen away from the hemoglobin?
- A fetus must also take the oxygen from the mother's hemoglobin, how can it do that?

- How many ways can you think of that carbon dioxide could exist in a solution. think of the carbon cycle.
- What does CO₂ do to the pH of a solution?
- Which part of the brain control pulse rate.

**Skills (can you ... ?)**

- Analyse oxygen dissociation curves for hemoglobin and myoglobin.
- Describe the consequences of high altitude for gas exchange.
- Say how breathing helps the pH of blood to be regulated to stay within the narrow range of 7.35 to 7.45.
- Give causes and treatments of emphysema.
- Identify pneumocytes, capillary endothelium cells and blood cells in light micrographs and electron micrographs of lung tissue.