

## HIGHER LEVEL SCIENCE BIOLOGY SYLLABUS

### 1. Keeping Healthy

A combination of a balanced diet and regular exercise is needed to help keep the body healthy.

#### 1.1. Diet and exercise

- a) A healthy diet contains the right balance of the different foods you need and the right amount of energy.
- b) The amount of energy expended by the body.
- c) Metabolic rate may be affected by inherited factors. Inherited factors also affect our health; for example cholesterol level.

#### 1.2. How our bodies defend themselves against infectious diseases

- a) Microorganisms that cause infectious disease are called pathogens.
- b) Bacteria and viruses may reproduce rapidly inside the body and may produce poisons (toxins) that make us feel ill. Viruses damage the cells in which they reproduce.
- c) The body has different ways of protecting itself against pathogens.
- d) White blood cells help to defend against pathogens by: Ingesting pathogens; producing antibodies, which destroy particular bacteria or viruses; producing antitoxins, which counteract the toxins released by the pathogens.
- e) Some medicines, including painkillers, help to relieve the symptoms of infectious disease, but do not kill the pathogens.
- f) Antibiotics, including penicillin, are medicines that help to cure bacterial disease by killing infectious bacteria inside the body.
- g) Antibiotics kill individual pathogens of the non-resistant strain. Individual resistant pathogens survive and reproduce, so the population of the resistant strain increases.
- h) People can be immunised against a disease by introducing small quantities of dead or in active forms of the pathogen into the body. Vaccination

### 2. Nerves and Hormones

The nervous system and hormones enable us to respond to external changes.

#### 2.1. The nervous system: Receptors, reflex action, impulse across synapse

#### 2.2. Control in the human body

- a) Internal conditions that are controlled include:
  - The water content of the body
  - The ion content of the body
  - Temperature
  - Blood sugar levels.
- b) Many processes within the body are coordinated by chemical substances called hormones.
- c) Several hormones are involved in the menstrual cycle of a woman:
  - LH
  - FSH
  - Oestrogen
- d) The uses of hormones in controlling fertility include:
  - Giving oral contraceptives that contain hormones to inhibit FSH production so that no eggs mature
  - Giving FSH and LH in a 'fertility drug' to a woman whose own level of FSH is too low to stimulate eggs to mature, for example in In Vitro Fertilisation (IVF) treatment.

- 2.3. Control in plants
- a) Plants are sensitive to light, moisture and gravity.
  - b) Plants produce hormones to coordinate and control growth. Auxin controls phototropism and gravitropism (geotropism).
  - c) Plant growth hormones are used in agriculture and horticulture as weed killers and as rooting hormones.

### **3. The use and abuse of drugs**

#### **3.1. Drugs**

- a) When new medical drugs are devised, they have to be extensively tested and trialled before being used.  
In the laboratory, using cells, tissues and live animals  
In clinical trials involving healthy volunteers and patients.
- b) Use of statins in lowering the risk of heart circulatory diseases.
- c) Thalidomide is a drug that was developed as a sleeping pill. It was also found to be effective in relieving morning sickness in pregnant women.
- d) Misuse of alcohol and nicotine.
- e) Drugs that an athlete can use to enhance performance.

### **4. Interdependence and Adaptation**

Organisms are well adapted to survive in their normal environment. Population size depends on a variety of factors including competition, predation, disease and human influences. Changes in the environment may affect the distribution and behaviour of organisms.

#### **4.1. Adaptations**

- a) Organisms, including microorganisms have features (Adaptations) that enable them to survive in the conditions in which they normally live.
- b) Some organisms live in environments that are very extreme. Extremophiles may be tolerant to high levels of salt, high temperatures or high pressures.
- (c) Animals and plants may be adapted for survival in the conditions where they normally live, e.g. deserts, the Arctic.

#### **4.2. Environmental change**

- a) Changes in the environment affect the distribution of living organisms.
- b) Living organisms can be used as indicators of pollution:  
Lichens  
Invertebrate

#### **4.3. Organisms and their environment**

Living organisms form communities and we need to understand the relationships within and between these communities. These relationships are affected by external influences.

- a) Physical factors that may affect organisms are:  
Temperature  
Availability of nutrients  
Amount of light  
Availability of water  
Availability of oxygen and carbon dioxide.
- b) Quantitative data on the distribution of organisms can be obtained by:  
Random sampling with quadrats  
Sampling along a transect.

#### **4.4. Energy and biomass in food chains**

#### **4.5. Waste materials from plants and animals**

- a) Decay processes
- b) The carbon cycle

### **5. Genetic variation, its control and Evolution**

#### **5.1. Genetic variation and its control**

- a) Why organisms are different
- b) Reproduction: Sexual, Asexual
- c) Modern cloning techniques: Tissue culture, Embryo transplants, adult cell cloning.
- d) Genetic engineering.

#### **5.2 Evolution**

Darwin's theory of evolution by natural selection  
Other theories, including that of Lamarck.

#### **5.3 Speciation**

Changes in the environment of plants and animals may cause them to die out. The fossil record shows that new organisms arise, flourish, and after time become extinct. The record also shows changes that lead to the formation of new species.

##### **5.3.1 Old and new species**

- a) Evidence for early forms of life comes from fossils.
- b) Extinction may be caused by:  
Changes to the environment over geological time  
New predators  
New diseases  
New, more successful competitors  
A single catastrophic event, eg massive volcanic eruptions or collisions with asteroids  
Through the cyclic nature of speciation.
- c) New species arise as a result of:  
Isolation  
Genetic variation  
Natural selection  
Speciation

### **6. Cells and simple cell transport**

All living things are made up of cells. The structures of different types of cells are related to their functions. To get into or out of cells, dissolved substances have to cross the cell membranes.

#### **6.1 Cells and cell structure**

- a) Human and animal cells:  
A nucleus  
Cytoplasm  
Cell membrane  
Mitochondria  
Ribosomes
- b) Plant and algal cells also have a cell wall made of cellulose, which strengthens the cell. Plant cells often have:  
Chloroplasts  
A permanent vacuole.

- c) Bacterial cell consists of cytoplasm and a membrane surrounded by a cell wall; the genes are not in a distinct nucleus.
- d) Yeast is a single-celled organism. Yeast cells have a nucleus, cytoplasm and a membrane surrounded by a cell wall.  
Cells may be specialised to carry out a particular function.

## **6.2 Diffusion**

Dissolved substances can move into and out of cells by diffusion.

## **6.3 Tissues, organs and organ systems:**

- a) A tissue is a group of cells with similar structure and function. Examples of tissues include:
  - Muscular tissue, which can contract to bring about movement
  - Glandular tissue, which can produce substances such as enzymes and hormones
  - Epithelial tissue, which covers some parts of the body.
- b) Organs are made of tissues. One organ may contain several tissues. The stomach is an organ that contains:
  - Muscular tissue, to churn the contents
  - Glandular tissue, to produce digestive juices
  - Epithelial tissue, to cover the outside and the inside of the stomach.
- c) Organ systems are groups of organs that perform a particular function.
- d) Plant organs include stems, roots and leaves. Examples of plant tissues include:
  - Epidermal tissues, which cover the plant
  - Mesophyll, which carries out photosynthesis
  - Xylem and phloem, which transport substances around the plant.

## **6.4. Photosynthesis**

Green plants and algae use light energy to make their own food. They obtain the raw materials they need to make this food from the air and the soil. The conditions in which plants are grown can be changed to promote growth.

- a) Equation for photosynthesis  
Carbon dioxide + water – glucose + oxygen
- b) The rate of photosynthesis may be limited by:
  - Shortage of light
  - Low temperature
  - Shortage of carbon dioxide.

## **7. Proteins – their functions and uses**

Proteins have many functions, both inside and outside the cells of living organisms. Proteins, as enzymes, are now used widely in the home and in industry.

### **7.1 Proteins**

- a) Protein molecules are made up of long chains of amino acids and form:
  - Structural components of tissues such as muscles
  - Hormones
  - Antibodies
  - Catalysts
- b) Enzymes:
  - The shape of an enzyme is vital for the enzyme's function. High temperatures change the shape. Different enzymes work best at different pH values.

## 8. Cell division and inheritance

Characteristics are passed on from one generation to the next in both plants and animals.

### 8.1 Interpret genetic diagrams, including family trees

8.2 Construct genetic diagrams of monohybrid crosses and predict the outcomes of monohybrid crosses and be able to use the terms homozygous, heterozygous, phenotype and genotype.

### 8.3 Cell division

- a) In body cells the chromosomes are normally found in pairs. Body cells divide by mitosis.
- b) The chromosomes contain the genetic information.
- c) When a body cell divides by mitosis:  
Copies of the genetic material are made.  
Then the cell divides once to form two genetically identical body cells.
- d) Meiosis: Cells in reproductive organs – testes and ovaries in humans – divide to form gametes.
- e) Cells from human embryos and adult bone marrow, called stem cells, can be made to differentiate into many different types of cells, eg nerve cells.

### 8.4 Genetic variation

- a) Sexual reproduction gives rise to variation
- b) In human females the sex chromosomes are the same (XX); in males the sex chromosomes are different (XY)
- c) Some characteristics are controlled by a single gene: Dominant allele, Recessive allele
- d) Chromosomes are made up of large molecules of DNA (Deoxyribo nucleic acid) which has a double helix structure. A gene is a small section of DNA.
- e) Each person (apart from identical twins) has unique DNA. This can be used to identify individuals in a process known as DNA fingerprinting.

### 8.5 Genetic disorders

- a) Some disorders are inherited.  
Polydactyly  
Cystic fibrosis

## 9. Gaseous exchange

### Aerobic and anaerobic respiration

Respiration in cells can take place aerobically or anaerobically. The energy released is used in a variety of ways. The human body needs to react to the increased demand for energy during exercise.

### 9.1 Aerobic respiration:

Oxygen + Glucose = Carbon dioxide + Water

- a) The chemical reactions inside cells are controlled by enzymes.
- b) During aerobic respiration (respiration that uses oxygen) chemical reactions occur that:  
Use glucose (a sugar) and oxygen  
Release energy.
- c) During exercise a number of changes take place:  
The heart rate increases

The rate and depth of breathing increases.

These changes increase the blood flow to the muscles and so increase the supply of sugar and oxygen and increase the rate of removal of carbon dioxide.

- d) Muscles store glucose as glycogen, which can then be converted back to glucose for use during exercise.

## **9.2 Anaerobic respiration**

- a) During exercise, if insufficient oxygen is reaching the muscles they use anaerobic respiration to obtain energy.
- b) Anaerobic respiration is the incomplete breakdown of glucose and produces lactic acid.
- c) Oxygen debt

## **10. Transport systems in plants and animals**

### **10.1 The blood system**

Heart structure and function

The blood components

Blood vessels: arteries, veins and capillaries

### **10.2 Transport systems in plants**

Flowering plants have separate transport systems:

Xylem tissue transports water and mineral ions from the roots to the stem and leaves

Phloem tissue carries dissolved sugars from the leaves to the rest of the plant, including the growing regions and the storage organs.

Factors affecting transpiration

## **11. Homeostasis**

### **11.1. Removal of waste and water control**

Waste products that have to be removed from the body

Function of a healthy kidney

Treatment by dialysis

Disadvantages of dialysis

Kidney transplants

### **11.2. Temperature control**

### **11.3. Sugar control**

## **12. Humans and their environment**

### **12.1 Waste from human activity**

Water pollution

Air pollution

Indicators of air pollution

Land pollution

### **12.2 Deforestation and the destruction of areas of peat**

Loss of biodiversity

Greenhouse gases  
Global warming

**12.3 *Biofuels***  
Biogas

**12.4 *Food production***

Mycoprotein