



Kelvinside Academy

Biology Higher  
Syllabus

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## **Unit 1: Cell Biology**

### **a) Cell structure in relation to function**

- i) Cell variety.
  - The concept of variation in structure between cells of one type of tissue and between cells of different types of tissue.
  - The existence of unicellular organisms.
  - The relationship of structure to function.
- ii) Absorption and secretion of materials.
  - Diffusion and osmosis as basic cell processes.
  - The role of the cell wall and plasma membrane in relation to these processes.
  - Cell wall: reference to cellulose fibres and permeability.
  - Plasma membrane: reference to fluid mosaic model.
  - Function of plasma membrane in relation to selective ion uptake (active transport) and absorption and release of chemicals.

### **b) Photosynthesis**

- 1. The role of light and photosynthetic pigments.
  - i) Absorption, transmission and reflection of light by a leaf.
  - ii) Role of chlorophyll and other photosynthetic pigments.
  - iii) Separation of photosynthetic pigments by means of chromatography.
- 2. Photolysis and carbon fixation.
  - The detailed structure of chloroplasts should be related to the stages of photosynthesis.
  - i) The location and significance of photolysis (the light dependent stage).
    - The production of ATP and hydrogen (for use in carbon fixation).
  - ii) The site of carbon fixation (Calvin cycle).
    - The production of glucose as a result of an enzyme-controlled sequence of reactions requiring ATP, hydrogen (from photolysis) and carbon dioxide.

### **c) Energy release**

The role and production of ATP.

- i) Importance of ATP as a means of transferring chemical energy. The role of ATP in cellular processes. Regeneration of ATP from adenosine diphosphate (ADP) and inorganic phosphate (Pi).
- ii) Glycolysis.  
The breakdown of glucose (6C) to pyruvic acid (3C) with a net production of ATP.  
Location of process within the cytoplasm.
- iii) Krebs (Tricarboxylic acid, Citric acid cycle.)  
The production of carbon dioxide and hydrogen.
- iv) The cytochrome system.  
The production of ATP and water.
- v) Mitochondrion structure.
- vi) Distinction between aerobic and anaerobic phases of respiration with reference to the level of ATP production and final metabolic products.

### **d) Synthesis and release of proteins**

The role of DNA, RNA and cellular organelles:

- i) The functional variety of proteins.
- ii) DNA: structure, in particular the double helix, nucleotides and bases; pairing of named bases; genes as regions of chromosomal DNA; importance of DNA replication.
- iii) RNA: single strand structure; replacement of thymine with uracil and deoxyribose with ribose; functions of mRNA and tRNA in synthesis of proteins; triplet code; codons and anti-codons.
- iv) Cellular organelles: ribosomes and rough endoplasmic reticulum. Distribution within the cell and function as site of translation in protein synthesis; role of endoplasmic reticulum in transporting proteins; role of Golgi apparatus in processing molecules for secretion.

### **e) Cellular response in defence in animals and plants**

- i) The nature of viruses and their invasion of cells.  
Alteration of cell instructions to produce more viruses.
- ii) Cellular defence mechanisms in animals.  
Phagocytosis.  
Antibody production.
- iii) Cellular defence mechanisms in plants.

## **Unit 2: Genetics and Adaptation (Higher)**

### **a) Variation**

1. Meiosis and the dihybrid cross.
  - i) Sexual reproduction as a means of enabling genetic variation to be maintained in the population and its importance in long-term evolutionary change.
  - ii) Outline of meiosis: haploid gamete production.  
Crossing over and independent assortment of chromosomes during meiosis: a means of producing new phenotypes.
  - iii) The dihybrid cross: expected F<sub>2</sub> phenotypic ratios.
2. Linkage and crossing over.
  - i) The existence of linked genes and their effect on the F<sub>2</sub> generation.  
Comparison of the distance between linked genes and the frequency of recombination.
  - ii) Crossing over of genes at chiasmata during meiosis resulting in recombinant gametes.  
Separation of linked genes as a source of variation.
  - iii) Sex linkage.
3. Mutation.
  - i) Characteristics of mutant alleles, to include random occurrence and low frequency.
  - ii) Mutagenic agents.
  - iii) Changes in the number of chromosomes through non-disjunction.
  - iv) Polyploidy: advantages in crop production.
  - v) Change in the structure of one chromosome (duplication, translocation, deletion, inversion).
  - vi) Alteration of base type or sequence (substitution, insertion, deletion, inversion).

### **b) Selection and speciation**

1. Natural selection.
  - i) The survival of those organisms best suited to their environment.
  - ii) The concept of the species.
  - iii) The importance of isolating mechanisms as barriers to gene exchange leading to evolution of new species.
  - iv) Adaptive radiation.
  - v) The high-speed evolution of organisms such as antibiotic resistant bacteria and the melanic peppered moth.
  - vi) The conservation of species through wildlife reserves, captive breeding and cell banks. The maintenance of genetic diversity.

2. Artificial selection.

- i) The evolution of a wide variety of crops and domesticated animals through selective breeding and hybridisation as undertaken by humans.
- ii) The contribution of genetic engineering to the development of new varieties. Somatic fusion in plants to produce new species.

**c) Animal and plant adaptations**

1. Maintaining a water balance.

Animals

- i) Osmoregulation in freshwater fish and saltwater bony fish.
- ii) Adaptations associated with salmon and eel migration.
- iii) Water conservation in a desert mammal.

Plants

- i) The transpiration stream.
- ii) Stomatal mechanism.
- iii) Adaptations in xerophytes and hydrophytes.

2. Obtaining food.

Animals

- i) Foraging behaviour and search patterns in animals.
- ii) Economics of foraging behaviour.
- iii) Examples of interspecific and intraspecific competition arising from scarcity of resources.
- iv) Dominance hierarchy and co-operative hunting within the social group.
- v) Territorial behaviour in relation to competition for food.

Plants

- i) Comparison of the sessility of plants and the mobility of animals.
- ii) Competition in plants mainly for light and soil nutrients.
- iii) The effect of grazing by herbivores on species diversity.
- iv) Comparison of the compensation point in sun and shade plants.

3. Coping with dangers.

Animals

- i) Avoidance behaviour and habituation.
- ii) Learning as a long- term modification of response.
- iii) Individual and social mechanisms for defence.

Plants

- i) Structural defence mechanisms.
- ii) Ability to tolerate grazing.

### **Unit 3: Control and Regulation (Higher)**

#### **a) Control of growth and development**

1. Growth differences between plants and animals.
  - i) Position and activity of meristems in plants, absence of meristems in animals.
  - ii) Formation of annual rings.
  - iii) Regeneration in angiosperms and mammals.
  - iv) Growth patterns in plants, and animals to include an annual plant, a tree, a human and a locust.
2. Genetic control.
  - i) An introduction to the Jacob- Monod hypothesis of gene action in bacteria.
  - ii) The part played by genes in controlling metabolic pathways as shown in the case of phenylketonuria.
  - iii) The control of cell differentiation by switching particular genes on or off.
3. Hormonal influences.
  - i) Pituitary hormones.

The role of the pituitary gland in the control of growth and development involving human growth hormone (GH) and thyroid stimulating hormone (TSH).
  - ii) Plant growth substances.

As exemplified by indole acetic (IAA) and gibberellic acid (GA).

Sites of production of IAA. Effects of IAA at cellular and organ levels; role in apical dominance, leaf abscission and fruit formation.

Effects of GA on dormancy and in dwarf varieties of plants.

Role of GA in  $\alpha$ -amylase induction in barley grains.

Practical applications of plant growth substances as illustrated by herbicides and rooting powders.
4. Environmental influences.
  - i) The importance of individual macro-elements.

Symptoms of deficiency of nitrogen, phosphorus, potassium and magnesium in plants.

The importance of iron and calcium in animals.

The inhibiting effect of lead on enzyme activity.

- ii) The effect of vitamin D deficiency in humans.
- iii) The effect of drugs on fetal development: thalidomide, alcohol, nicotine.
- iv) Light.
  - The effect of light on vegetative shoot growth and development.
  - The effect of light on flowering in long- day and short- day plants.
  - The effect of light on the timing of breeding in birds and mammals.

## **b) Physiological homeostasis**

The principal of negative feedback:

- i) The need to maintain conditions within tolerable limits.
- ii) Water content of blood and concentration of cell chemicals.
- iii) Glucose and energy needs of tissue.
- iv) Temperature: the importance of temperature to enzyme- controlled metabolic processes in the body.
- v) Endotherms and ectotherms.

## **c) Population dynamics**

Regulation of plant and animal populations:

- i) Population fluctuations: the relative stability of populations, despite short- term oscillations in number.
- ii) Factors influencing population change.
  - Density- independent factors to include temperature and rainfall.
  - Density- dependent factors to include disease, food supply, predation and competition.
- iii) Monitoring populations.
  - The need to monitor wild populations.
- iv) Succession and climax in plant communities.