



NAZARBAYEV  
UNIVERSITY

**Foundation Year Programme**

**Entrance Tests**

**BIOLOGY SPECIFICATION**

**NUFYP SET 2017**



# Biology

## 1. Cells

1.1. Describe the structure and function of animal cells (liver cell) to include:

- a. cell membrane
- b. cytoplasm
- c. nucleus
- d. mitochondrion.

1.2. Describe the structure and function of plant cells (palisade cell) to include:

- a. cell membrane
- b. cytoplasm
- c. nucleus
- d. cell wall
- e. chloroplast
- f. mitochondrion
- g. vacuole.

1.3. Describe differences in structure between typical animal and plant cells.

1.4. Know the levels of organisation as: cells to tissues to organs to organ systems:

- a. relate the structure of the following to their functions: ciliated cells – in respiratory tract, root hair cells – absorption, xylem vessels – conduction and support, muscle cells – contraction, red blood cells – transport
- b. define tissue, organ, and organ system.

## 2. Movement across membranes

2.1. Know the definition of and examples of diffusion e.g. gas exchange in the lungs and in plant leaves; absorption in small intestine; mineral ions in roots

2.2. Know the definition of and examples of osmosis e.g. uptake of water by plants; effects on plant and animal tissues

2.3. Know the definition of and examples of active transport e.g. ion uptake by root hairs; uptake of glucose by epithelial cells of villi.

### 3. Cell division and sex determination

#### 3.1. Mitosis:

- a. define as nuclear division that leads to two daughter cells that have the same number of chromosomes so are genetically identical to each other and the parental cell
- b. recall the role of mitosis in growth of tissues by increasing cell number, repair of tissues, replacement of worn out cells and asexual reproduction.

#### 3.2. Meiosis:

- a. define as nuclear and cell division that produces daughter cells, known as gametes, in which the chromosome number is halved from diploid to haploid so will have a single set of chromosomes. Each daughter cell will be genetically different, resulting in genetic variation
- b. recall the role of meiosis in reducing the chromosome number so that the full chromosome complement, two sets of chromosomes (diploid), is restored at fertilisation.

#### 3.3. Asexual and sexual reproduction:

- a. understand that asexual reproduction involves one parent and offspring are genetically identical
- b. recall that asexual reproduction produces clones
- c. understand that sexual reproduction involves two parents, and offspring are genetically different, leading to (increased) variation
- d. recall that sexual reproduction involves the fusion of haploid nuclei to form a diploid zygote and genetically dissimilar offspring.

#### 3.4. Sex determination:

- a. recall that, in most mammals, females are XX and males are XY
- b. be able to establish the gender of offspring
- c. be able to work out gender ratio.

### 4. Inheritance

- 4.1. Recall the nucleus as a site of genetic material/chromosomes/genes in plant and animal cells.

4.2. Describe and understand the following genetic terms:

- a. genes
- b. alleles
- c. dominant
- d. recessive
- e. heterozygous
- f. homozygous
- g. phenotype
- h. genotype
- i. chromosome
- j. haploid nucleus
- k. diploid nucleus.

4.3. Monohybrid crosses:

- a. use and interpret genetic diagrams to depict monohybrid crosses
- b. express the outcome as ratios, numbers, probabilities or percentages.

4.4. Define *inheritance* as the transmission of genetic information from generation to generation.

## 5. DNA and protein synthesis

5.1. Understand that chromosomes contain DNA.

5.2. Describe the structure of DNA:

- a. know that one molecule of DNA is made up of two long chains (strands) coiled together to form a double helix
- b. know that each of the two DNA strands contains chemicals called bases with cross-links between the strands, formed by pairs of bases
- c. know that A always pairs with T, and C always pairs with G, and that it is the order of these bases that forms a code.

5.3. Protein synthesis:

- a. understand that genes carry the code for proteins
- b. understand that the genetic code is 'read' as triplets of bases and know each triplet codes for an amino acid
- c. understand that protein synthesis involves the production of proteins from amino acids.

#### 5.4. Gene mutations:

- a. appreciate that a change in the gene/DNA is a gene mutation
- b. describe mutations in the number of chromosomes as a source of variation, as shown by Down's syndrome
- c. outline the effects of ionising radiation and chemicals on the rate of mutation.

### 6. Variation

#### 6.1. Sources of variation:

- a. understand that continuous variation observed by phenotypes can be a result of genetic/inherited and/or environmental effects
- b. understand that discontinuous variation is caused by genes alone and results in a limited number of distinct phenotypes with no intermediates, e.g. A, B, AB and O blood groups in humans.

### 7. Enzymes

#### 7.1. Biological catalysts:

- a. recall that enzymes are proteins that function as biological catalysts
- b. understand the meaning of the term *biological catalyst*.

#### 7.2. Understand the factors affecting enzyme action, such as:

- a. temperature
- b. pH.

#### 7.3. Digestive enzymes:

- a. know the role of amylase, protease and lipase in digestion.

### 8. Animal physiology

#### 8.1. Respiration:

- a. define *respiration* and recall the uses of energy in the human body
- b. describe aerobic respiration
- c. recall the word equation for aerobic respiration
- d. describe anaerobic respiration in animals
- e. recall the word equation for anaerobic respiration in animals and yeast
- f. compare aerobic respiration with anaerobic respiration in muscles during hard exercise in animals in terms of relative amounts of energy released
- g. describe the role of anaerobic respiration in yeast during brewing and bread-making.

## 8.2. Organ systems:

- a. coordination and response:
  - i. recall that the central nervous system comprises the brain and spinal cord, and describe the structure and function of sensory neurons, relay (connector) neurons, motor (effector) neurons, synapses and the reflex arc as a means of automatically and rapidly integrating and coordinating stimuli with responses
- b. gas exchange:
  - i. recall the structure and function of the breathing system, including the structure of the thorax, including larynx, trachea, bronchi, bronchioles, alveoli and associated capillaries
  - ii. recall differences in composition between inspired and expired air and the use of limewater as a test for carbon dioxide to investigate these differences
  - iii. recall the processes of ventilation and gas exchange
- c. recall the structure and function of the circulatory system including:
  - i. the heart (and the presence and role of the SAN and AVN)
  - ii. the blood vessels (arteries, veins and capillaries)
  - iii. the structure and function of different blood cells including red blood cells, white blood cells and platelets
- d. define *nutrition* and recall the structure (including the main regions of the alimentary canal and associated organs) and function of the human digestive system, including:
  - i. diet and food supply – understand the term *balanced diet* and recall the main sources and importance of carbohydrates, fats, proteins, vitamins C and D, mineral ions (calcium and iron), fibre and water
  - ii. mechanical and physical digestion – identify types of human teeth and their structure, function, care; peristalsis; the role of bile
  - iii. chemical digestion – state where amylase, protease and lipase enzymes are secreted in the alimentary canal, and the functions and end products of these digestive enzymes
  - iv. absorption – identify the significance of villi in increasing internal surface area
  - v. assimilation – understand it as the movement of digested food molecules into the cells of the body where they are used, becoming part of the cells

- e. define *excretion*:
  - i. recall the structure and function of the kidney in terms of the removal of urea and excess water and reabsorption of glucose and some salts, and the relative positions of ureters, bladder and urethra in the body
  - ii. recall the process of excretion in humans including the substances excreted.

### 8.3. Homeostasis:

- a. recall that homeostasis is the maintenance of a constant internal environment, and understand the concept of negative feedback using the skin as an example, to maintain a constant body temperature through sweating, shivering, vasodilation and vasoconstriction, and the coordinating role of the brain.

### 8.4. Hormones:

- a. define *hormones* and recall that hormones travel in the blood to their target organs. Use adrenaline and its role in the chemical control of metabolic activity as an example.

## 9. Environment

### 9.1. Food chains:

- a. understand the flow of energy in a food chain from producer to consumer (herbivore) to another consumer (carnivore) including energy losses between trophic levels including decomposers
- b. understand that the energy flow limits the length of a food chain
- c. understand the pyramids of:
  - i. biomass
  - ii. number.

### 9.2. Population size:

- a. appreciate that a population can change in size due to the factors affecting the rate of population growth for a population of an organism (food supply, predation and disease).

### 9.3. Variety of life:

- a. list and define the main characteristics of living organisms including nutrition, excretion, respiration, sensitivity, reproduction, growth and movement



- b. understand the concept and use of a classificatory system:
  - i. define and describe the *binomial system* of naming species (genus and species)
  - ii. list the main features of the vertebrates: mammals, birds, reptiles, amphibians and bony fish
  - iii. list the main features used in the classification of: flowering plants (monocotyledons and dicotyledons), arthropods (insects, crustaceans, arachnids and myriapods), annelids, nematodes and molluscs
  - iv. use simple dichotomous keys based on easily identifiable features.

## 10. Plant physiology

### 10.1. Photosynthesis:

- a. define and recall nutrition in plants
- b. understand the role of chlorophyll, light and carbon dioxide
- c. recall the word equation for photosynthesis
- d. understand that the release of oxygen and carbon dioxide depends on the relative rates of photosynthesis and respiration
- e. identify, label and recall the function of the leaf structure including the cuticle, cellular and tissue structure of a dicotyledonous leaf as seen in cross-sections under the light microscope
- f. understand the importance of nitrate ions for protein synthesis and magnesium ions for chlorophyll synthesis.

### 10.2. Respiration:

- a. recall that plant cells obtain energy from respiration using products of photosynthesis.

### 10.3. Transport in plants:

- a. describe the structure of the xylem and phloem
- b. define and recall transport in plants to include:
  - i. water uptake – through root hair cells, root cortex cells, xylem vessels, mesophyll cells
  - ii. transpiration – including the effects of variation of temperature, humidity and light intensity on the transpiration rate
  - iii. translocation – in terms of the movement of sucrose and amino acids in phloem sieve tubes.

## 11. Sexual reproduction in humans

11.1. Recall the structure and function of the male reproductive system to include:

- a. the testes
- b. scrotum
- c. sperm ducts
- d. prostate gland
- e. urethra
- f. penis.

11.2. Recall the structure and function of the female reproductive system to include:

- a. the ovaries
- b. oviducts
- c. uterus
- d. cervix
- e. vagina.

11.3. Recall the menstrual cycle in terms of changes in the uterus and ovaries (no knowledge of control by hormones is required).

11.4. Outline sexual intercourse and describe fertilisation in terms of the joining of the nuclei of male gamete (sperm) and the female gamete (egg).

11.5. Outline early development of the zygote simply in terms of the formation of a ball of cells that becomes implanted in the wall of the uterus.

11.6. Outline the growth and development of the fetus in terms of increasing complexity in the early stages and increasing size towards the end of pregnancy.

11.7. Describe the function of the placenta and umbilical cord in relation to the exchange of dissolved nutrients, gases and excretory products (no structural details are required).





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