-SQA-SCOTTISH QUALIFICATIONS AUTHORITY

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NATIONAL CERTIFICATE MODULE DESCRIPTOR

-Module Number- **7311011** **-Session-1991-92**
-Superclass- **RH**

-Title- **NUCLEIC ACIDS AND PROTEIN SYNTHESIS ($x^1/_2$)**

-DESCRIPTION-

Purpose

This module provides students with the means of extending their knowledge of the functions of the cell nucleus.

The module is suitable for inclusion in Biology or Human Biology programmes and in conjunction with other Stage 2 Biology modules could be a preparation for Higher Education.

Preferred Entry Level

7310011	Introducing Cell Structure and Function,
7310021	Introducing Cell Processes,
7311021	Cell Biochemistry, or Standard Grade Biology at Grade 3.

Outcomes

The student should:

1. apply the concept of molecular structure to nucleic acids;

2. apply the concept of the genetic code to protein synthesis;

3. apply the concept of the gene to gene expression and gene mutation.

Assessment Procedures

Acceptable performance in this module will be satisfactory achievement of all the Performance Criteria specified for each Outcome.

The following abbreviations are used below:

PC Performance Criteria
IA Instrument of Assessment

Note: The Outcomes and PCs are mandatory and cannot be altered. The IA may be altered by arrangement with SQA. (Where a range of performance is indicated, this should be regarded as an extension of the PCs and is therefore mandatory.)

OUTCOME 1 **APPLY THE CONCEPT OF MOLECULAR STRUCTURE TO NUCLEIC ACIDS**

PCs

(a) The description of the structure of nucleic acids is correct with respect to:

(i) constituent molecules;
(ii) arrangement of constituent molecules;
(iii) bonding.

(b) The application of the concept is correct in relation to:

(i) replication;
(ii) transcription.

IA Structured Questions

3 structured questions to assess the student's ability to apply the concept of molecular structure to nucleic acids.

The questions should be allocated as follows:

PC (a) 1 question
(b)(i) 1 question on replication
(b)(ii) 1 question on transcription

Satisfactory achievement of the Outcome will be demonstrated by the student achieving all the Performance Criteria.

OUTCOME 2 **APPLY THE CONCEPT OF THE GENETIC CODE TO PROTEIN SYNTHESIS**

PCs

(a) The description of the genetic code is correct.
(b) The description of protein synthesis is correct with respect to:

(i) mRNA;
(ii) tRNA;
(iii) ribosomes;
(iv) protein formation.

(c) The solutions of problems involving given base sequences are correct.

IA Objective Questions

10 objective questions to assess the student's ability to apply the concept of the genetic code to protein synthesis.

The questions should be allocated as follows:

PC (a) 1 question
(b) 4 questions
(c) 5 questions

Several types of objective question would be suitable for the above assessments.

Satisfactory achievement of the Outcome will be demonstrated by the student achieving the correct response for (a), 4 correct responses for (b) and 3 correct responses for (c).

OUTCOME 3 **APPLY THE CONCEPT OF THE GENE TO GENE EXPRESSION AND GENE MUTATION**

PCs

(a) The description of the gene is correct with respect to:

(i) chromosome structure;
(ii) nucleic acid structure.

(b) The description of gene expression is correct with respect to:

(i) regulatory genes;
(ii) promotor and operator genes;
(iii) structural genes.

(c) The description of the role of DNA in the control of cell metabolism is correct in terms of synthesis of proteins.

(d) The explanation of the possible consequences of gene mutation is correct in terms of protein structure and function.

IA Structured Questions

3 structured questions to assess the student's ability to apply the concept of the gene to gene expression and gene mutation.

The questions should be structured in such a way that each part of the Performance Criteria can be achieved at least once within the 3 questions.

Satisfactory achievement of the Outcome will be demonstrated by the student achieving all the Performance Criteria.

The following sections of the descriptor are offered as guidance.
They are not mandatory.

CONTENT/CONTEXT

General

The three main themes running through the study of nucleic acids are:

1. how information can be encoded and stored within the cell;

2. how the information in the cell can be replicated;

3. how the information in the cell can be used to control development and metabolism.

These themes are often covered as a series of separate events, but it is also important that the students develop the concept of the cell as having a dynamic, yet strictly regulated metabolism. Nucleic acids are central to this.

Corresponding to Outcomes 1-3:

1. (a) The student should understand the structure of DNA in terms of sugar phosphate backbone, the different bases present and their pairing, the arrangement of the component molecules and overall shape of the molecule.

   The differences between RNA and DNA should be limited to the number of strands in the molecule, the substitution of uracil for thymine in DNA. The difference in sugars involved should be limited to there being one fewer oxygen atom in ribose sugar than in deoxyribose sugar.

   The student should understand the difference between stronger, chemical bonds and weaker attractive bonds.

   (b) The student should be able to explain DNA replication in terms of unwinding of the DNA molecule, separation of the component strands, arrangement of nucleotides by base pairing, the polymerisation of the new DNA strands (including reference to the role of enzymes), and the rewinding of the daughter DNA molecules.

   Care should be taken to stress the conservation of the base sequence of the DNA throughout replication.

   Transcription should be similarly understood as separation of DNA strands, arrangement of nucleotides by base pairing and polymerisation to form the RNA chain.

Though both replication and transcription are explained as a series of stages, the students should be made aware that each is a continuous process rather than a series of discreet stages.

2. (a) The student should be able to explain the genetic code in terms of the order of bases on a strand of DNA.

The application of the concept to protein synthesis should be such that the codon is established as the unit of the genetic code.

(b) Before meeting protein synthesis, it is recommended that students should be aware of the basic structure of proteins in terms of their amino acid composition, the uniqueness of the order of amino acids making up proteins and the importance of this to their shape and function.

Translation should be understood in terms of the role of mRNA and tRNA in aligning amino acids in a certain order at the ribosome and their polymerisation of the amino acids to form a polypeptide chain.

The role of the ribosome should be understood as the site of translation and a source of some of the enzymes involved.

Students should also be made aware that protein formation may involve the folding or rearrangement of the polypeptide chain, or the combining of a number of chains to form a protein molecule.

3. (a) A clear link between the order of bases in DNA to protein formation leads to the concept of a gene as a functional unit. Students should also be made aware of the relationship between DNA and the chromosome.

(b) The concept of gene expression should be understood in terms of the Jacob and Monod Operon theory including:

Regulatory genes - which produce a cytoplasmic product which may bind to the DNA in order to regulate gene expression. The products of the regulatory genes may require the presence of a co-repressor or inducer.

Structural genes - which generally produce a structural or enzymatically active protein as their product.

(c) Students should be able to identify gene change as an insertion, inversion, duplication, deletion or substitution. Students should be able to explain why the severity of the effects of mutation are often linked to the numbers of bases affected, the effect on the sequence of codons within the DNA, the order of amino acids in the polypeptides thus formed and, therefore, the structure and function of the proteins formed.

SUGGESTED LEARNING AND TEACHING APPROACHES

During the work of the module students should have several opportunities to practise their skills. Each student should be assessed at appropriate points throughout the module. Where a student is unsuccessful in achieving an Outcome, provision should be made for remediation and reassessment.

A student-centred, resource-based approach is likely to be the most flexible for this module. The Outcomes can be integrated so that concepts can be developed.

Selection of data, tabulating and drawing conclusions are examples of a problem-solving approach appropriate for establishing concepts.

Resource material in the form of publications, audio-visual material and computer software may be available.

This module could be integrated with 7311041 Genetics (x 1/2) or other Stage 2 Biology modules.