Assessment Schedule – 2012

Biology: Demonstrate understanding of gene expression (91159)

Assessment Criteria

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding involves defining, using annotated diagrams or models to explain, and giving characteristics of, or an account of, gene expression.	Demonstrate in-depth understanding involves providing a reason as to how or why biological ideas and processes affect gene expression.	Demonstrate comprehensive understanding involves linking biological ideas and processes about gene expression. The explanation may involve justifying, relating, evaluating, comparing and contrasting, or analysing.

Evidence Statement

Q	Expected Coverage	Achievement	Merit	Excellence
ONE	**A mutagen** is a physical or chemical agent that changes the genetic material, usually DNA, of an organism and thus increases the frequency of mutations above the natural background level, eg: • radiation • toxins • virus. Mutagens can alter the genotype by causing an increase in the rate of a gene mutation or a chromosome mutation. In both cases the genotype is changed. A gene mutation is a change in the base sequence of a gene (do NOT accept change in genetic code), which results in a new allele. Gene mutations can be of two fundamentally different kinds: • **Base substitution:** In this case one base in the DNA is substituted for another. Eg, instead of CAT there could be CGT. • **Frame shifts:** These occur when a base is inserted or deleted, changing the reading frame of each triplet code. This can alter the 'meaning' of all the bases that follow the shift.	• Gives an appropriate account of a mutagen and gives an example. e.g. A mutagen increases the chances / rate of / causes mutation. For example UV light. • Defines mutation. Eg, mutation is a change in the base sequence of a gene. • Gives an account of or uses simple annotated diagram(s) to show a type of gene mutation. Eg a substitution mutation may occur where one base is swapped for a different one that changes the sequence. • Defines phenotype. Eg characteristics caused by a combination of genes and the environment.	• Gives reasons how/why the genotype is affected by the mutagens. Eg, links mutagen to a mutation to an allele change to a change in genotype. • Explains more than one example of gene mutation, eg both substitution and frame shift explained. • Provides a reason why there is a difference between the phenotype and the genotype because of the environment. Eg, genotype may give you white skin but the sunlight can make this darker or lighter altering the phenotype but not the genotype.	Links the factors that result in the phenotype by clearly comparing AND contrasting the effects of the genotype and the environment. Eg the genotype of an organism may set the upper and lower limits for a trait whilst the environment determines where within this range the phenotype ends up. Key terms must be included in the discussion and a clear cohesive example discussed that includes reference to the concept of Mutagens, Mutations and environmental factors.

	The phenotype of an organism results from the interaction between the genotype and the environment. It is the composite of the characteristics shown by the cell or organism under a particular set of environmental conditions. The expression of the genotype can be affected by the environmental conditions that exist internally or externally for an organism without the genotype itself being altered in any way. Environmental factors vary widely, but can include temperature, wind, salinity, available nutrients etc. (Any reasonable/ appropriate environmental factors can be accepted). The genotype provides the instruction set for a particular structure or function, but this may not be able to be fully expressed if the environmental conditions work against it. Eg, plant height is controlled by both genotype and environment. If a cutting is taken from a plant that is prostrate (grows close to the ground) due to the environmental factor of the wind, when it is grown in a sheltered garden the genotype is expressed fully and the result is a tall plant. The genotype of the plant has not changed at all, so this is not the case of a tall plant genotype vs. a prostrate genotype.	• Gives an account of an environmental factor. Eg, a plant can't reach its full potential height if nutrients are insufficient to support its growth.		

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	Provides any ONE statement from Achievement.	Provides any TWO statements from Achievement.	Provides any THREE statements from Achievement.	Provides any FOUR statements from Achievement.	Provides any TWO statements from Merit.	Provides all THREE statements from Merit.	Provides the criteria for Excellence.	Provides the criteria for Excellence AND the answer is justified with clear examples.

Q	Expected Coverage	Achievement	Merit	Excellence

TWO
(a)
	Understanding of transcription is shown by the base-pairing rules for DNA and RNA.
	Sequences are completed to be:
	TACCGTCTAAGA
	ATGGCAGATTCT
		• In (a) correctly completes both strands.
		• Circles strand 1 label.
		• In (b) defines degeneracy, eg each amino acid can have more than one codon code for it.
		• In (c) gives an account of at least THREE of the following:
		  • translation
		  • ribosomes
		  • tRNA
		  • codons & anticodons
		  • start & stop codons
		  • polypeptide chains.
		• In (c) gives TWO ADDITIONAL accounts from the points above.
			• In (b) gives reasons how/why more than one codon can code for the same amino acid (with an example) e.g. there are more codons than amino acids therefore each amino acid can have more than one codon code for it. for example UUU and UUC both code for PHE.
			• In (b) explains why degeneracy leads to redundancy e.g. more than one codon for an amino acid means that some codons are redundant - the process of protein synthesis could function without them **OR** how redundancy offers an advantage when mutations occur. Eg, for many codons, a mutation in the third base would lead to no change in the amino acid coded for.
			• In (c) gives a reason for the complementary nature of the relationship between <u>codons</u> and <u>anticodons</u> and how this relationship works.
			• In (c) gives a reason for the relationship between the <u>codon</u> and the <u>amino acids</u> and how this relationship works.
			• In (c) gives a reason for the relationship between <u>tRNA and amino acids</u> and how this relationship works.
				In (c) relates (most/all) the structures and explanations of their associated functions to comprehensively show understanding of the process of translation.

(b)	The genetic code has redundancy due to the fact that two or more codons can specify the same amino acid. (This is known as degeneracy.) For example, codons GAA and GAG both specify glutamic acid (GLU). [Any example can be given.] This means that there are more codons than amino acids so in any given translation, some codons will be redundant.			
(c)	Translation is where the code sequence carried on the mRNA is used to create a functional protein. First, mRNA has to leave the nucleus via pores in the nucleus. mRNA forms a complex with a ribosome, which is close to the nucleus (usually on the endoplasmic reticulum). The ribosome is an organelle, which 'reads' mRNA bases in a code of three bases at a time. This is known as a codon. tRNA brings in amino acids – there is a different kind of tRNA for each amino acid. Three unpaired bases on the tRNA are known as an anticodon. They are complementary to a codon on the mRNA. Codon-anticodon 'matches' combine with base pairing, thus bringing the correct amino acid to the next part of the sequence. A start codon initiates the translation. Peptide bonds form between amino acids building a polypeptide chain. A stop codon ends translation. The polypeptide chain is released from the ribosome and 'folds' into a three-dimensional structure, becoming a functional protein.			

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	Provides any ONE statement from Achievement.	Provides any TWO statements from Achievement.	Provides any THREE statements from Achievement.	Provides any FOUR statements from Achievement.	Provides any TWO statements from Merit.	Provides THREE statements from Merit.	Provides the criteria for Excellence for MOST structures.	Provides the criteria for Excellence for ALL structures.

Q	Expected Coverage	Achievement	Merit	Excellence
THREE	A metabolic pathway is a series of biochemical reactions that are connected by their intermediates: The reactants (or substrates) of one reaction are the products of the previous one, and so on. Because there are a series of biochemical reactions, each one usually controlled by an enzyme, there are multiple places where the end result can be affected. As with most metabolic pathways in our body, the first compound in a pathway is converted to the next compound by the action of an enzyme. For example, in the simple pathway A → B → C, the conversion of compound A to B occurs because of the action of enzyme 1, and the conversion of B to C occurs because of the action of enzyme 2. A mutation can occur which stops the function of enzyme 1, then the end product can not be made even if enzyme 2 is fully functional. In another individual, a mutation can occur which stops the function of enzyme 2, then the end product can not be made even if enzyme 1 is fully functional. There are a number of possible combinations to the way in which a condition can be inherited because the metabolic pathway has at least two points where different genes are controlling the outcome. If both parents have porphyria, they must both have alleles, which result in the deficiency of one of the enzymes at one of the points of the pathway. Normal children can be born, because if the points which are affected in the parents are different, then each one of those can be dominated by an allele inherited from the other, resulting in normal production of the enzyme. Eg: (There are many possibilities, so any correct combination linked to the diagram should be accepted.) Parent 1 is unable to produce ALA synthetase, but parent 2 does. Parent 2 is unable to produce Protoporphyrinogen – oxidase but parent 1 does. In this case, both of the enzymes that are causing the respective breaks in the metabolic pathway can be produced successfully in the offspring and they will not suffer from porphyria.	• Describes the term metabolic pathway, eg a series of enzyme controlled reactions. • Gives an account of and / or uses annotated diagram(s) to show how the metabolic pathway may be affected when enzymes are deficient (may annotate the existing diagram). Eg the pathway stops at point X and there is a build up of product Y. • Describes the fact that enzymes are deficient due to mutation. • Describes the fact that different enzymes may be lacking in each of the two parents OR that the mutated allele may be dominant and both parents heterozygous for the same gene.	• Provides a reason to how a metabolic pathway can have one or more defective enzymes due to mutations in the alleles that code for their production. Eg, if a mutation affects the gene for a particular enzyme the enzyme will not be produced or malfunction, due to the incorrect amino acid sequence, leading to a deficiency. • Provides a reason why different mutations can stop the pathway even if other parts of the pathway are normal. • Provides a reason for how normal children can be born from parents who both have porphyria. Eg, could inherit an allele for the functioning enzyme from both parents, (valid in either context BUT not at E level).	• Evaluates the diagram correctly to show how the combinations can lead to normal offspring from affected parents by discussing the fact that different enzymes may be lacking in each of the two parents. • Appropriate examples must be cited from the diagram throughout.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	Some relevant writing but does not fulfil any statement from Achievement.	Provides any ONE statement from Achievement.	Provides any TWO statements from Achievement.	Provides any THREE statements from Achievement.	Provides any TWO statements from Merit.	Provides all THREE statements from Merit.	Provides the EITHER statement for Excellence.	Provides BOTH statements for Excellence.

Judgement Statement

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 6	7 – 12	13 – 18	19 – 24