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91159



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Level 2 Biology, 2015

91159 Demonstrate understanding of gene expression

9.30 a.m. Monday 16 November 2015
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of gene expression.	Demonstrate in-depth understanding of gene expression.	Demonstrate comprehensive understanding of gene expression.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–11 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Merit

TOTAL

18

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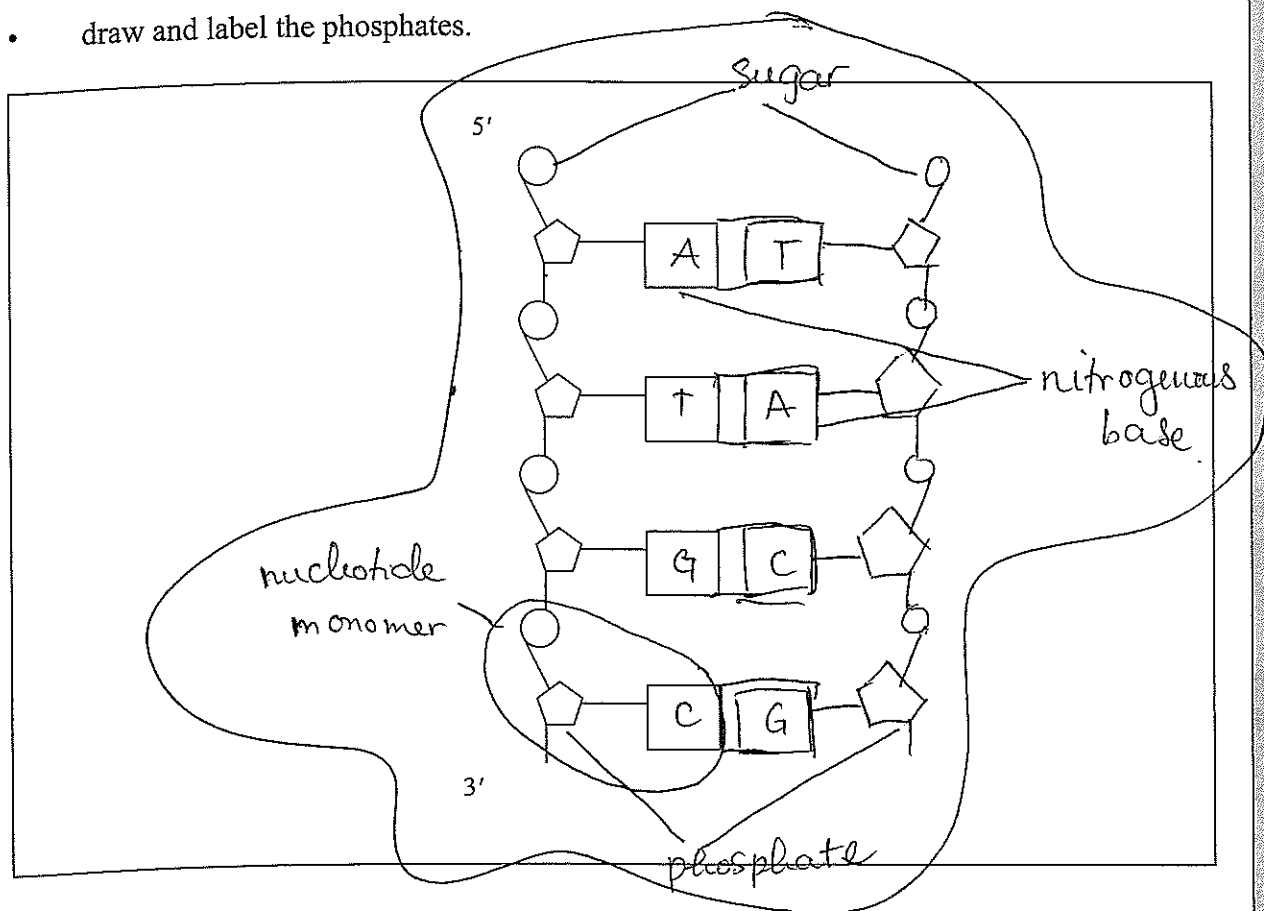
QUESTION ONE: MAKING PROTEINS

- (a) The structure of DNA is made up of nitrogen bases, deoxyribose sugars, and phosphates.

Draw the corresponding **anti-parallel** complementary strand in the box below.

In your answer:

- fill in the template strand containing the bases adenine (A), thymine (T), guanine (G), cytosine (C)
- draw the corresponding **anti-parallel** complementary strand
- draw and label the sugars
- draw and label the phosphates.



- (b) Protein synthesis is the process of making proteins. Triplets, codons, and anti-codons are important components in the process.

Discuss the relationship between triplets, codons, and anti-codons, and how they interact to form a protein.

In your answer include:

- a description of a triplet, codon, and anti-codon
- an explanation of what a start codon and a stop codon are
- a discussion of how triplets, codons, and anti-codons interact during transcription and translation to form a protein.

You may use diagrams in your answer.

Each triplet consist of three continuous bases in the DNA. Codon is a sequence of 3 bases in the mRNA that is complementary to the triplets of DNA using the base pairing rule (A-T, C-G) except for T being replaced by U in mRNA. Anticodon is also a 3 bases sequence, but it is complementary to the codons of mRNA using the base pairing rule similar to the one of mRNA.

When the DNA is unwound, the information of ~~carried~~ it forms 2 separate strands, the template strand and the coding strand. The template strand consist of numerous triplets, the triplets ~~are~~ are sequences of 3 base. The free ^{RNA} nucleotide will match with the triplets to transcribe the mRNA chain according to the base pairing rule (A-T, C-G) except there is no T base in the T base is replaced with U in mRNA. This process continues until the termination is reached. The new sequence of 3 bases form in the translation of protein ~~process~~ synthesis is called codons and make up a chain of mRNA, a transcribed copy of DNA that is able to move out of the nucleus to the ribosome in the cytoplasm for the ~~the~~ translation of ^{process} protein synthesis. (X) the ribosome joins the mRNA strand ~~at~~ at the start codon (AUG) which signals the beginning of translation. The start codon (AUG) will attract a tRNA with

There is more space for your answer to this question on the following page.

bring an anti^{codon} anticodon - ^{another} sequence of 3 bases, of ~~UAG~~ that has 3 bases of UAG ^{start} and that is complementary to the codon (AUG) tRNA ~~at~~ with anticodon also carries a MET amino acid with ~~it~~ the next tRNA will bring another anticodon ^{that is complementary to the next codon of mRNA} and amino acid to the site where ribosome join with mRNA. A peptide chain is formed between the ~~2~~ 2 amino acids and the first tRNA is released. The third tRNA will bring another anticodon that matches the ^{next codon of} mRNA and a specific amino acid. Another peptide ~~char~~ bond is formed ^{between the second and third amino acid and the second tRNA is released} and third amino acid. This continues until a long poly the stop codon is reached and a long polypeptide formed. The ^{role of the} interaction between codons of ^{mRNA} ~~DNA~~ and anticodons of tRNA is that the correct amino acid will be placed in the correct order in the ~~pol~~ to form a polypeptide.

(*) The interaction between the triplets of DNA & the codons of mRNA is to make a ^{transcribed} copy of genetic information that can travel to ribosome for protein synthesis.

Different anticodon comes with different amino acid.

QUESTION TWO: METABOLIC PATHWAYS

In 1941 biologists George Beadle and Edward Tatum exposed the bread mould *Neurospora crassa* to radiation. The mutated moulds lost their ability to produce an amino acid (arginine), and this slowed or stopped their growth. However, they found when they provided the mould with the amino acid arginine, growth was restored. They concluded that a gene mutation inactivates an enzyme needed to synthesise the amino acid in a metabolic pathway.

(a) Describe what a gene mutation is.

gene mutation is the change in the base sequence of DNA that can cause an essential (enzyme) protein not to be produced or the protein to be produced by not being able to produce the correct amino acids. Gene mutation can be caused by mutagen. in this case, radiation.

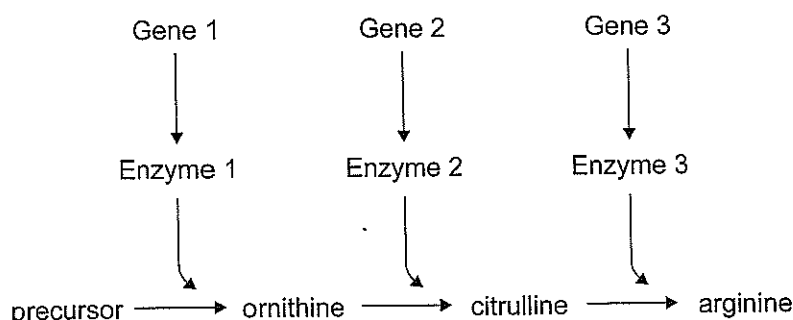
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- (b) The biologists carried out further experiments and found three mutations prevented the amino acid arginine from being made.

Using the *Neurospora crassa* metabolic pathway below, discuss why there are three mutations that can occur for the amino acid arginine not to be produced.

In your answer:

- explain what a metabolic pathway is
- discuss why a mutation to any one of the genes can result in arginine not being produced
- discuss why the biologists concluded 'One Gene Codes for One Protein'.



A metabolic pathway is a series of enzyme-controlled ^{biochemical reactions} steps that involve the conversion of 1 substance into another. The product of 1 reaction becomes the substrate for the next reaction.

There are 3 enzymes involved in this metabolic pathway. So there are 3 mutations that can occur for the amino acid ^{arginine} not to be produced. For example, if a ^{mistake is made during the DNA replication} mutation occurs in gene 1 that codes for the production of enzyme 1, a mutation occurs. The enzyme 1 cannot be produced and therefore ornithine or a non-functioning enzyme formed is unable to catalyse precursor to ornithine. This leads to the accumulation in the body and no ornithine to be produced to ~~continue~~ ^{proceed} for other steps in which means the metabolic pathway.

has been stopped and therefore the conversion of precursor to arginine impossible for arginine amino acid to be the final product the same thing. If the mutation cause enzyme 2 or enzyme 3 not to be produced than the same outcome occurs, no amino acid arginine to be made.

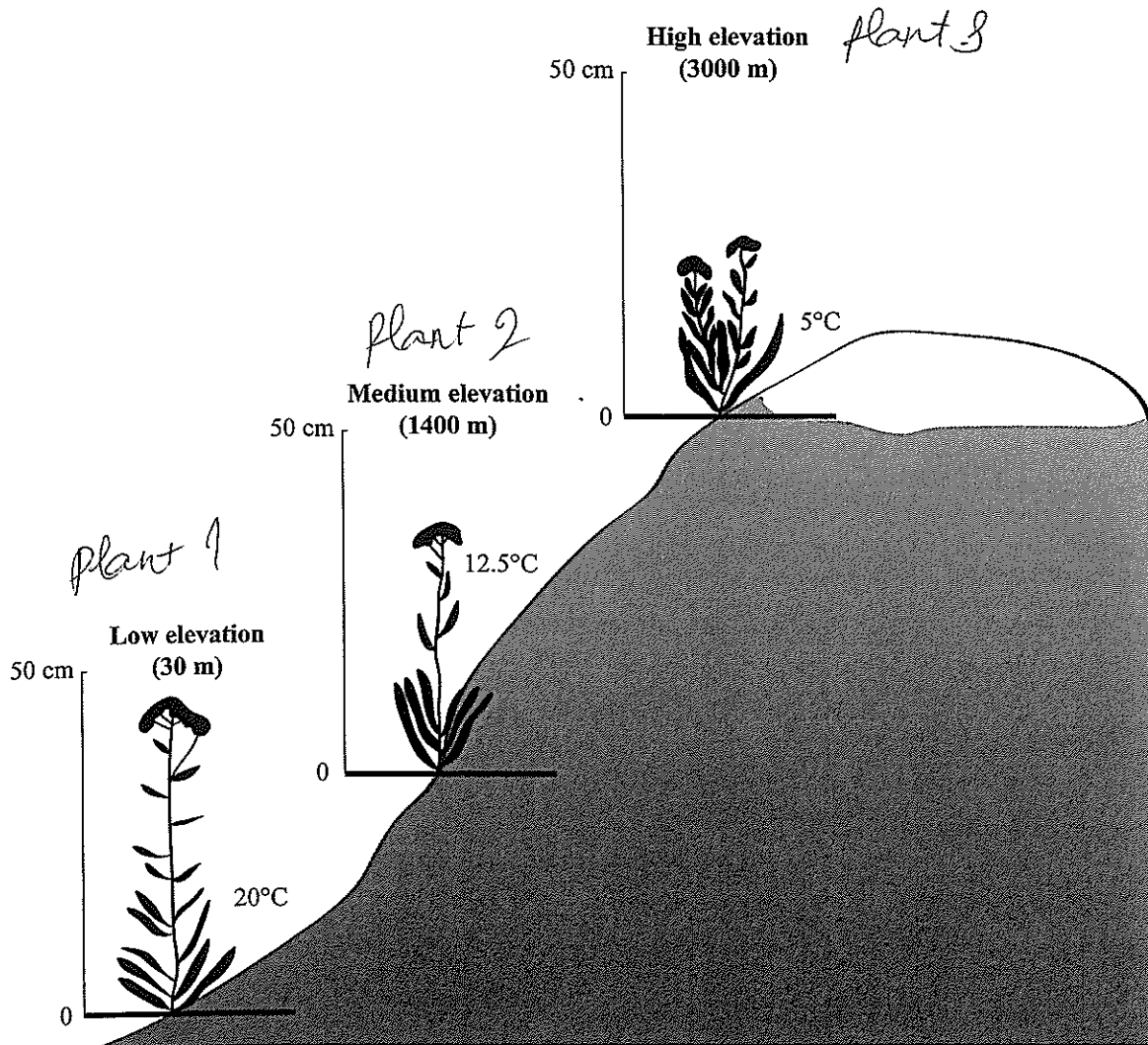
One gene codes for one protein because the gene carries specific genetic information that provide instruction for protein to be made, so different protein is coded for different genes.

the specific information determine the shape structure and function of protein

QUESTION THREE: ENVIRONMENT, GENOTYPE INTERACTIONS

The common yarrow plant, *Achillea millefolium*, can be cut into several sections, and each section will grow asexually (reproduces without fertilisation or exchanging gametes) when put into soil. In an experiment, biologists cut one yarrow plant into three sections and planted each section at a different elevation to determine how phenotype is affected by the environment. See figure below.

Achillea millefolium growth response to different elevations



Adapted from http://www.flyfishingdevon.co.uk/salmon/year3/psyc364evolutionary_psychobiology/psy364_genotype_phenotype/psy364_genotype_phenotype.htm

- (a) Describe the difference between genotype and phenotype.

Genotype is the alleles that an individual carries for a particular characteristic. Phenotype is the expression of genotype under a certain environmental condition.

- (b) Explain why the biologists used genetically identical cuttings, at the different elevations.

By using genetically identical cuttings, we can tell that the differences in the phenotype (growth and height) of the 3 cuttings are caused by the environment.

by the environmental factors ~~like~~ e.g. elevations and temperature and not genetic factors

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(c) Analyse the results shown in the figure on the previous page.

In your answer include:

- an explanation of why plants may grow differently at different elevations
- a discussion of the interaction between temperature, genotype, and phenotype expression
- a discussion of environmental factors that would influence the yarrow plants' genetic expression.

Plants may grow differently at different elevations due to the environmental of temperature at which the plant is exposed to. At a low elevation of 30m, the temperature is relative high (20°C) which is ~~per~~ the best conditions out of the 3 for plant to grow. This does not affect the genotype of a plant but ^{significant effect} does change the growth rate of the plant when compare to plant 2 and 3 at different elevations & different temperature. ~~(*)~~ the higher the elevation, the colder it gets, and this can ~~be~~ slow down the rate of growth in plant. Plant 3 being ~~affected~~ planted in the coldest environment ~~has been~~ is the shortest in height (about 25cm). ~~It is a~~ plant again the environment has no effect on the genotype of the plant. Plant 2 being planted at a medium elevation show the ~~phenotype~~ it is shorter than plant 1 but taller than plant 3. The environmental ~~of wind~~ has a vivid effect on the growth of 3 plants with the ~~(*)~~ plant 1 is twice as tall as plant 2 ^{so} that are identical genetically.

which means the phenotype is the expression of genotype under certain condition

Annotated Exemplar Template

Excellence exemplar for 91159 2015		Total score	18
Q	Grade score	Annotation	
1	M6	This candidate has provided a number of ideas demonstrating knowledge of aspects of the protein synthesis process. They have shown an explanation of aspects of the process such as the role of the template strand. With more knowledge about the role of the stop codon/the ribosome movement and/or the interactions of the enzyme during transcription this grade would be at excellence.	
2	M6	This candidate has provided a number of ideas demonstrating knowledge of aspects of the metabolic process. They have provided a clear understanding of how a mutation in DNA will result in a protein /enzyme that has no/less function. They have a clear link to one gene coding for each enzyme. For excellence the candidate needed to apply their knowledge to more of the metabolic pathway and elaborate on the one gene-one protein idea.	
3	M6	The candidate showed clear knowledge that the genotype, the alleles carried, does not change with a change in environment (temperature) and has related this to the 3 plants. For an excellence more is required on the enzymes effected by the heat or the change to gene expression.	