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Level 2 Biology 2022

91159 Demonstrate understanding of gene expression

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 room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2 – 12 in the correct order and that none of these pages is blank.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

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

Achievement

TOTAL 10

QUESTION ONE: PROTEIN SYNTHESIS

Translation is an important step in protein synthesis.

Source: https://www.thinglink.com/scene/750792545688092673

Discuss the importance of translation, and why the DNA strand is not directly translated into a polypeptide chain.

In your answer:

- describe protein synthesis
- explain translation
- discuss the relationship between codons, anticodons, tRNA, mRNA, and amino acids
- justify with TWO reasons why DNA is not directly translated into a polypeptide chain.

could get damaged

mRNA can't returned to the nucleus as it

Protein synthesis is the process where information is taken from the DNA (in the nucleus) and read then used to create proteins. it is generally broken up into 2 parts transcription and translation. transcription is where parts of the DNA are copied and mRNA and taken into the cytoplasm of a cell and to a ribosome. Translation is where the ribosome and tRNA work together to read the instructions and build the protein. So, the mRNA feeds into the ribosome, one codon at a time (codons are sets of 3 bases, with parts of the information needed to build the protein) the tRNA also comes to the ribosome and supplies it with the anticodons and amino acids needed to help build the

polypeptide chain. Anti codons are the opposite of codons. codons (in mRNA) are made up of base pairs either uracil, adenine, ~~glucose~~ glu or ~~cytosine~~ cytosine represented with the letters U, A, G, and C. (in DNA T is used instead of U, they just replace eachother) and they ~~Anticodons~~ match up together A with U (or T) and C with G. Anticodons are what the tRNA brings with the pair for the codon. For example if the codon was CAU, the anticodon would be GUA. tRNA also adds amino acids which are used to hold the polypeptide chain together. (the polypeptide chain is a long chain of amino acids that breaks apart/folds down on itself into proteins.

~~DNA~~ 2 of the reasons the cell dosnt just use the DNA to create proteins - instead copy the information during transcription and then use the duplicate - are 1 to keep the DNA safe and 2 because the DNA wouldnt have to be returned.

If the original DNA was brought out of the nucleus it would risk being damaged, since there is only one copy of the DNA (instructions to build proteins) the cell cannot risk losing / damaging it, because if they do it wont be able to create that protein, which could potentially cause the cell and eventually the organism to die.

The other reason is because after the protein is built the mRNA, ribosome, polypeptide chain and any amino acids still involved break apart and are left to be used as fuel or just excreted by the cell, this means there would be no way for the DNA to get back to where its stored in the nucleus. It is also a risk for the cell to allow things to go into the nucleus because it could possibly let in something dangerous or just not the right thing that could cause damage to the DNA.

QUESTION TWO: THE GENETIC CODE

A mutation in the gene coding for the enzyme tyrosine causes albinism, a condition that results in a decrease in the production of the pigment melanin. These individuals have albino phenotypes, because melanin gives pigment to their skin, hair, and eyes.

Source: https://www.quora.com/Can-animals-have-albinism

(a) ★ Describe what a mutation is.

~~A mutation is where the information in DNA is altered permanently~~

where the nucleotides in DNA are altered - substituted, deleted, or added and it can either have an effect or no effect.

(b) Different point mutations can cause albinism.

Discuss the effect of point mutations on final proteins.

In your answer:

- describe an insertion, deletion, and substitution mutation
- name the type of point mutation that is unlikely to change the protein, and explain why
- name the type of point mutation that would change the protein the most, and explain why
- discuss how these mutations affect the length and expression of the DNA base sequence
- discuss the degeneracy in the genetic code.

there are 3 types of mutations, insertion, deletion and substitution

insertion is where a nucleotide is added to the list of DNA, ~~base pairs~~, deletion is where one of the nucleotides are taken out and substitution is where one nucleotide is swapped for another.

An insertion: AUG CUG → ACU GCU G

deletion AUG CUG → AUG CG

substitution: AUG CUG → AUG CUA

The mutations most likely to have not much affect on a protein is substitution, as it only effects one nucleotide in the whole sense, and there is a ~~pretty~~ chance that the codon will code for the same proteins. like the proteins for UAA, UAG and UGA → they are all the same stop proteins but have different nucleotides in the codons that make them so say for the "G" in UGA was ~~substitu~~ Mutated and substituted for an A it would ~~still~~ change to UAA and still code for the same protein so there is a possibility for no visible affect — this is called a silent mutation.

The mutations that ARE likely to have a ~~huge~~ big affect on the construction of proteins are insertion and deletion, this is because it effects the whole polypeptide ~~change~~ chain after ~~the~~ where the mutation is; changing the instructions completely, for example if the sequence went AUG CUA GCU and the second "U" was deleted it would read AUG CAG CU, making the sequence shorter and read completely differently. even to the point where the sequence couldn't start at all, say a C was added to the first codon, it would read ACU GCU AUC U, making it longer, ~~code~~ code for different proteins and also ~~Arg~~ AUG is the start protein so when it was changed it meant the ribosome wouldn't read where to start ~~making~~ the protein and the tRNA's anticodon wouldn't fit.

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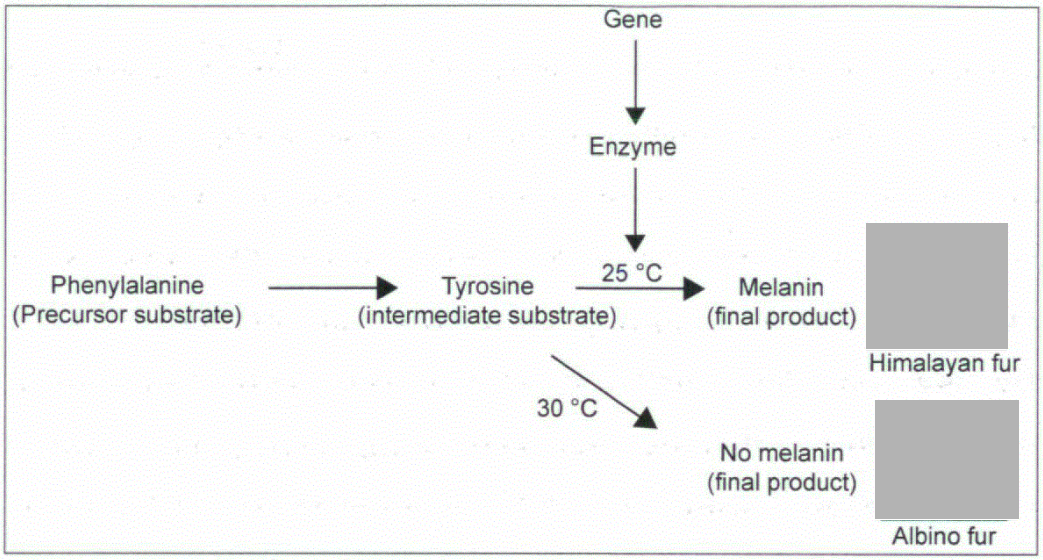
Degeneracy is where a mutation is expressed and it has an effect on the protein, this means the protein cant be created. This degeneracy can cause lacks of proteins, since they cant be made, and this can make the organism run inefficiently or cause death. This degeneracy can also be passed on hereditarily so it could possibly get mixed into the gene pool and effect offspring who then pass it on to their offspring. This is how hereditary illnesses get passed on, things like celiac disease or even just having weak knees or a susceptability to a certain illness.

QUESTION THREE: GENE EXPRESSION AND ENVIRONMENT

Himalayan rabbits show a mutant form of albinism that is temperature sensitive.

At lower temperatures (below 25 °C), the gene produces melanin (black) in fur. The enzyme is inactive at higher temperatures (above 30 °C) and produces no melanin (white) in fur. The average body temperature of a Himalayan rabbit is 37 °C.

Simplified metabolic pathway



Adapted from: https://arba.net/recognized-breeds/ and https://animalcorner.org/rabbit-breeds/himalayan-rabbit-breed/

Discuss how genes, enzymes, and the environment control the expression of melanin in Himalayan rabbits.

In your answer:

- describe what a metabolic pathway is
- explain a metabolic pathway using the terms precursor, substrate, intermediate, enzyme, gene, and final product
- discuss why Himalayan rabbits have dark melanin expression in their body extremities such as nose, ears, feet, and tail, and not in their core body
- discuss the environmental conditions necessary for Himalayan rabbits to express melanin (all black) AND no melanin (all white) fur colour for their entire life span.

a metabolic pathway is a seriese of reactions where the product of a reaction becomes the reactant for the next. The precursor, or precursor substrate is the beginer reactant of the reactions, the first one that starts the metabolic pathway. Substrates are the reactants for each reaction. The intermediate is the middle (or sense of middle) reactions in the pathway. ~~Enzymes~~ Genes are added to the pathway to react with the substrates and create the

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product, and enzymes are also added to speed up the reaction. And the final product is what you end up with at the end of the metabolic pathways.

Himilayan rabbits are more likely to have darker melanin (dark fur) in their extremities, areas like their paws, nose, ears and tail because those areas arent as close to the body, therefore they are colder, or get cold easier (since they arent as close to the heart which is pumping warm blood all throughout the body) they also cool down faster due to them being smaller and also away from the heart. Basically, less blood → less warm. And since melanin is still produced until the body temperature is more than 30°C (and these areas are likely colder than that) melanin will still be produced there.

IF rabbits wanted to produce melanin all over their body, or in order for them to do that, it would require them to live in an environment that lowers their body temperature like in the snow or high altitudes. The colder temperature in the environment would lower the rabbits body temperature enough for melanin to be produced all over (less than 25°C) and if the rabbit wanted to be albino, white all over with no melanin produced it would have to seek a warmer habitat one that kept its ears, feet and nose warm, like a forest the warmer environment temperature (above 30°C) would make it too hot for melanin to be produced, so the rabbit would then phenotypically albino. That change could be reversed. For rabbits that live in environments with violent season changes, like really hot

in the summer and really cold in the winter (→ alpine weather), the rabbit could change from being albino to having ~~tyrosinase~~ black coats throughout the year → in winter, when they are colder than 25°C melanin would be produced all over making them fully black, but in summer when the weather is hot, and their body temperatures are higher than 30°C they could become phenotypically albino, and inbetween, like autum and spring, the rabbit could be a mix of both.

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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QUESTION NUMBER

Standard	91159	Display ID	61597135	**Total score**	10
		NSN			
Q	**Grade score**	**Annotation**			
1	A4	Describes protein synthesis; mRNA; tRNA and polypeptide.			
2	A3	Describes a substitution and intersection/deletion mutation. Describes substitution unlikely to change a protein. Describe deletion/insertion mostly likely to change the protein.			
3	A3	Describes a metabolic pathway; percussor and final product.			