2.7 Gene Expression

AS. 91159

Protein Synthesis

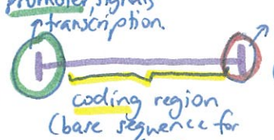
(1) TRANSCRIPTION (2) TRANSLATION → occurs in ribosomes in cell cytoplasm.
*mRNA carries code from DNA → ribosomes

DNA —(codes)→ mRNA —(codes)→ amino acids —(codes)→ proteins → us!
(nucleus) –transcription
(cytoplasm) –translation
} gene expression.

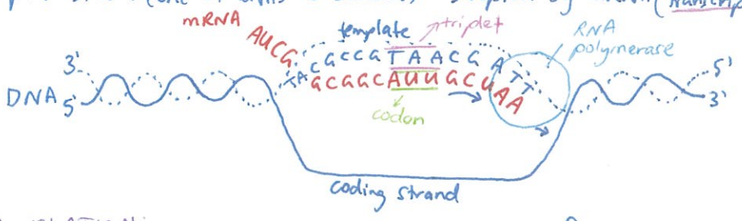
triplet = 3x bases on DNA. ···→ codes for one amino acid (Met)

(1) TRANSCRIPTION:

gene for lactase → gene has 3 regions



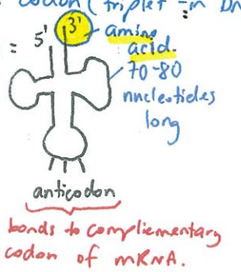
* occurs in nucleus.
* RNA polymerase binds to promoter, DNA 'unwinds' and 'unzips'
* Template strand (one of DNA's 2 strands) ⇒ copied by mRNA (transcription).

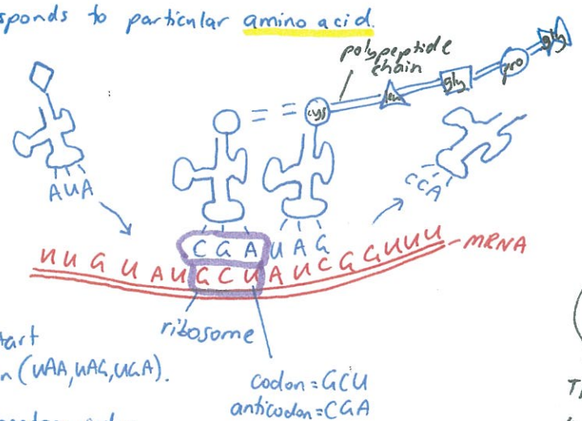


(2) TRANSLATION:

*occurs in cytoplasm.
* mRNA leaves nucleus, travels to ribosomes → made of protein and rRNA.

* ribosomes 'read' coded message on mRNA, 3 bases at a time (codon).
* Each codon (triplet in DNA) corresponds to particular amino acid.
* tRNA =





* ribosomes move along mRNA from start codon (AUG) until it reaches a STOP codon (UAA, UAG, UGA).
<when tRNA anticodon matches complimentary codon, amino acid attached to that tRNA is bonded to polypeptide chain.
> Polypeptide chain folds, coils, to form protein.

Redundancy: 64 possible triplet combinations (therefore: 64 possible codons.) from 3 bases (triplet) and 4 possible bases (A, T, G, C).

* genetic code is redundant as many amino acids can be specified or by more than one codon. e.g (Leu) has 6x possible codons.

Advantage = if mutation, there is a chance it still codes for same amino acid. ⇒ can still function same.

no Thymine, mRNA, tRNA, rRNA.
bases A, U, G, C. — RNA — single stranded
uracil replaces Thymine. ribose sugar
found in cytoplasm (made in nucleus).

in nucleus — DNA — double-stranded
bases T, A, G, C
deoxyribose sugar

(X-rays, UV). ionising radiation
chemical compounds which break DNA strands. ← **Mutagen:** carcinogens, viruses (Hep. B). environmental factor that changes genetic material (DNA) → increasing rate of mutations (remember: without mutagens, mutations will still occur "spontaneously" (via DNA replication, repair, recombination).

Gene (change base sequence) → **Mutations:**

(not in this topic) Chromosome (changes whole genes or chromosomes).

① a.k.a BASE SUBSTITUTION → nonsense? mis-sense? → can be silent/same sense (code is redundant).
② BASE INSERTION
③ BASE DELETION
} reading frameshift error. → almost always damaging unless occurring at end of gene.

* Any change in function of protein produces a change in phenotype of individual.

Fibrous proteins: tough rope-like bundles = collagen + keratin
↳ tendons, ligaments, muscles, bone.

Globular proteins: irregularly folded into 3-D shape e.g. enzymes and hormones.

Proteins: are polymers, made up of amino acids (monomers).

20 different amino acids, structure of protein is determined by amino acid sequence.

information to make these = stored in genes. → length of DNA which codes for a polypept

mutation? → mis-sense, non-sense, same-sense (silent)

enzyme-substrate complex. globular protein

Enzymes: active site = most important part.
- denatured – pH (H-bonds), – temp.
- mutation? → knock-on effect if in metabolic pathway.
- may not alter function of protein e.g if not on enzyme active site. Substrate specific

Main Topics:

1. Protein Synthesis ✓
2. Mutations ✓
3. Metabolic Pathways ✓
4. Environmental Effects on Phenotype
5. Enzymes ✓

Metabolic Pathways:

need to know how to ↗ interpret diagrams, no need to memorise a flow diagram.

chemical processes occurring as sequence of enzyme-controlled pathways

what happens if mutation in enzyme ↗ part of a pathway?

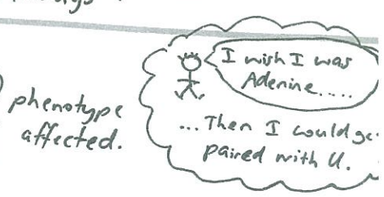
think about possible build-up of intermediates and loss of final products. } phenotype affected.

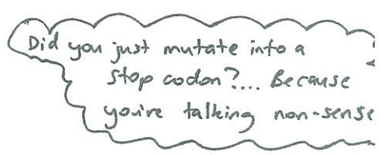
Metabolism: chemical processes that take place within cells.

They are all linked into networks through shared substrates e.g phenylalanine (amino acid) is needed for melanin (via series of steps) and thyroxine (via series of steps).

Product of one enzyme-controlled reaction becomes substrate for the next.

* negative feedback: sufficient end-product = pathway stops.





Environmental Effects on Phenotype:

genotype + environment → phenotype

* these changes are not heritable

egs (3 genes)
- skin colour and sun exposure → genotype unchanged but phenotype modified
- nutrient availability
- temperature
- altitude
- latitude
- acidity levels
- weather (wind) → e.g slanting trees

examples:

* TSD (temperature-dependent sex determination i.e in reptiles... ↓°C = males in turtles. ↑°C = females in tuatara and lizards.
* Colour pointing: i.e in cats: mutation → heat sensitive enzyme → high temps = no melanin (enzyme denatured) → = only coloured on