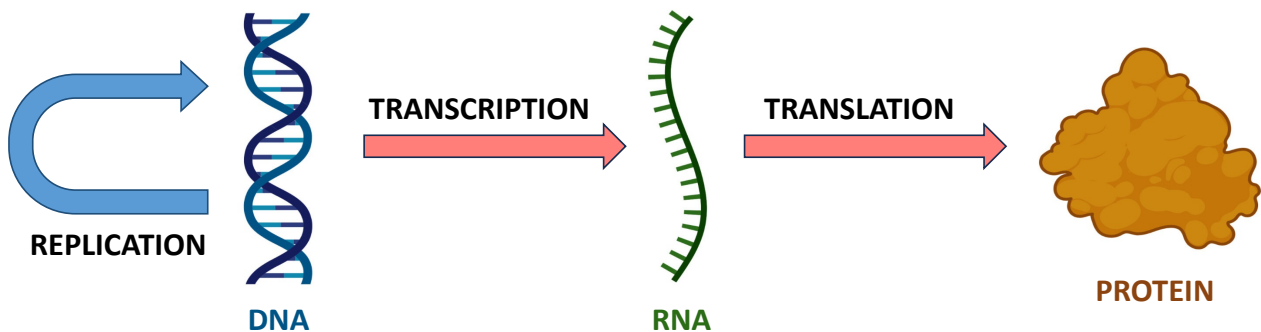


4.1 – TRANSCRIPTION

- D1.2.1** Transcription as the synthesis of RNA using a DNA template
- D1.2.2** Role of hydrogen bonding and complementary base pairing in transcription
- D1.2.3** Stability of DNA templates
- D1.2.4** Transcription as a process required for the expression of genes
- D1.2.6** Roles of mRNA, ribosomes and tRNA in translation

GENETIC INFORMATION

Describe the central dogma of molecular biology regarding the flow of genetic information within cells



DNA TEMPLATES

Outline how the organisation of DNA within cells promotes the stability of template sequences

Double-Stranded DNA:

Packaging via Histone Proteins:

TRANSCRIPTION

Distinguish between the template strand (antisense) and coding strand (sense) on DNA

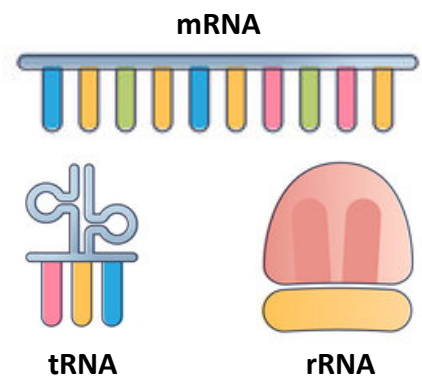
Template Strand	Coding Strand

Outline the process of transcription (DNA → RNA)

Include: RNA polymerase, gene, promoter, free RNA nucleotides, complementary base pairing

TYPES OF RNA

Identify the three main types of RNA, including their role within the process of gene expression



GENE EXPRESSION

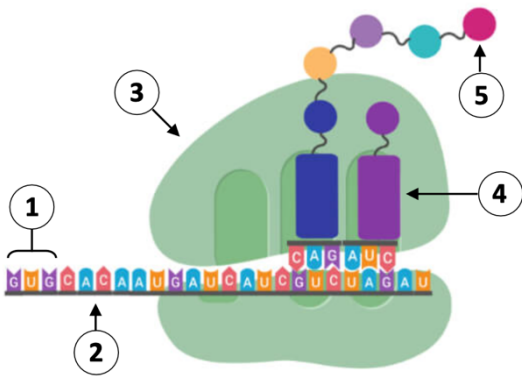
Explain the role of transcription in differential gene expression

4.2 – TRANSLATION

- D1.2.5 Translation as the synthesis of polypeptides from mRNA
- D1.2.6 Role of mRNA, ribosomes and tRNA in translation
- D1.2.7 Complementary base pairing between tRNA and mRNA
- D1.2.8 Features of the genetic code
- D1.2.9 Using the genetic code expressed as a table of mRNA codons
- D1.2.10 Stepwise movement of the ribosome along mRNA and linkage of amino acids by peptide bonding to the growing polypeptide chain
- D1.2.11 Mutations that change protein structure

TRANSLATION

Label the structures identified in the diagram below



1. _____
2. _____
3. _____
4. _____
5. _____

Explain how a polypeptide is synthesised via the process of translation

Include: mRNA, ribosome, codons, anticodons, tRNA, amino acids, peptide bonds, polypeptide chain

Compare and contrast the structure of ribosomes in prokaryotic and eukaryotic cells

GENETIC CODE

Use the genetic code to translate the sequence:

DNA: TAC AAA TTC GTA CTG CAC TCC
GGA ACA CAG TAG CCA AGT ACT

mRNA: _____

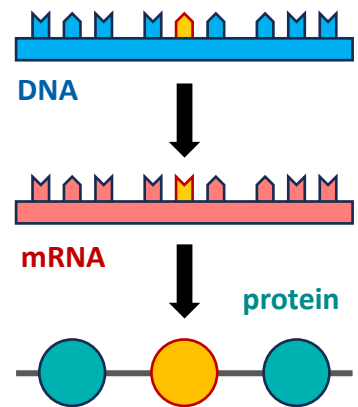
Protein: _____

UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys
UUC		UCC		UAC		UGC	
UUA	Leu	UCA		UAA	STOP	UGA	STOP
UUG		UCG		UAG		UGG	Trp
CUU		CCU	Pro	CAU	His	CGU	Arg
CUC	Leu	CCC		CAC		CGC	
CUA		CCA		CAA	Gln	CGA	
CUG		CCG		CAG		CGG	
AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser
AUC		ACC		AAC		AGC	
AUA		ACA		AAA	Lys	AGA	Arg
AUG	Met	ACG		AAG		AGG	
GUU		GCU	Ala	GAU	Asp	GGU	Gly
GUC	Val	GCC		GAC		GGC	
GUA		GCA		GAA	Glu	GGA	
GUG		GCG		GAG		GGG	

Identify the two main properties of the genetic code and describe their significance to translation

PROTEIN STRUCTURE

Outline how changes to a DNA sequence can alter the protein structure



Describe how changes to the sequence of DNA can cause genetic diseases such as sickle cell anaemia

4.3 – MUTATIONS

- D1.3.1** Gene mutations as structural changes to genes at the molecular level
- D1.3.2** Consequences of base substitutions
- D1.3.3** Consequences of insertions and deletions
- D1.3.4** Causes of gene mutations
- D1.3.5** Randomness in mutations
- D1.3.6** Consequences of mutation in germ cells and somatic cells
- D1.3.7** Mutations as a source of genetic variation

GENE MUTATIONS

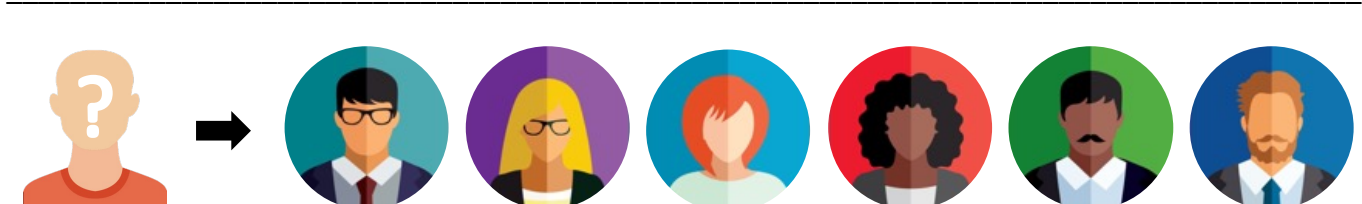
Define the following terms

Gene:

Mutation:

Distinguish between germline mutations and somatic mutations

Describe how randomness in mutation promotes genetic variation



GENE MUTATIONS

Identify examples of the different types of mutagens

Physical:

Chemical:

Biological:

TYPES OF MUTATIONS

Distinguish between base substitution mutations and frameshift mutations

Describe the three types of base substitution mutations

1. _____
2. _____
3. _____

Describe the two types of frameshift mutations

1. _____
2. _____

A T G C A T

NORMAL SEQUENCE

A T A C A T

BASE SUBSTITUTION

A T A G C A T

FRAMESHIFT MUTATION

4.4 – TRANSCRIPTION (AHL)

D1.2.12 Directionality of transcription and translation

D1.2.13 Initiation of transcription at the promoter

D1.2.14 Non-coding sequences in DNA do not code for polypeptides

D1.2.15 Post-transcriptional modification in eukaryotic cells

D1.2.16 Alternative splicing of exons to produce variants of a protein from a single gene

GENE STRUCTURE

Outline the three core components of a gene

1. _____
2. _____
3. _____



NON-CODING DNA

Distinguish between coding and non-coding DNA

Identify functions of non-coding DNA

- S _____
- T _____
- I _____
- N _____
- G _____



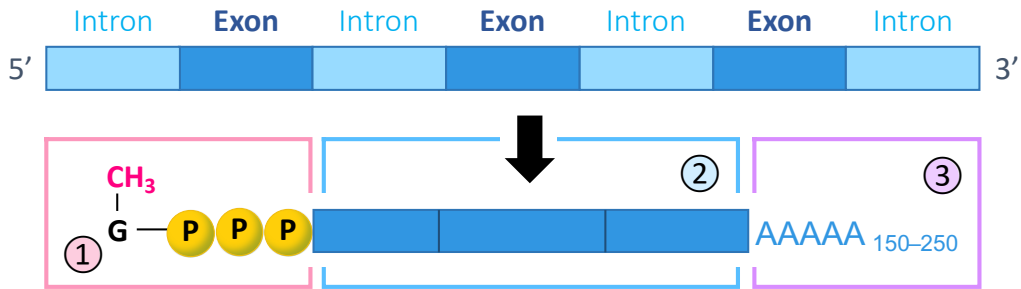
DIRECTIONALITY

State the directionality of transcription

POST-TRANSCRIPTIONAL MODIFICATIONS

Identify the three types of post-transcriptional modifications that occur within eukaryotic cells

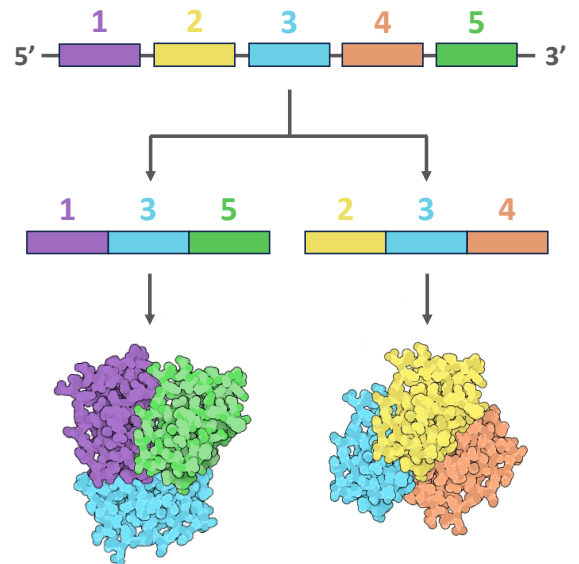
1. _____
2. _____
3. _____



Explain why RNA processing does not occur within prokaryotic cells (**note: Archaea may contain introns**)

ALTERNATIVE SPLICING

Explain how alternative splicing produces protein variants



TRANSCRIPTIONAL REGULATION

Outline how transcription can be regulated at the promoter

4.5 – TRANSLATION (AHL)

- D1.2.17** Initiation of translation
- D1.2.18** Modification of polypeptides into their functional state
- D1.2.19** Recycling of amino acids by proteasomes
- B1.2.6** Chemical diversity in the R-groups of amino acids as a basis for the immense diversity in protein form and function
- B1.2.7** Impact of primary structure on the conformation of proteins
- B1.2.8** Pleating and coiling of secondary structure of proteins
- B1.2.9** Dependence of tertiary structure on hydrogen bonds, ionic bonds, disulfide covalent bonds and hydrophobic interactions
- B1.2.10** Effect of polar and non-polar amino acids on tertiary structure of proteins
- B1.2.11** Quaternary structure of non-conjugated and conjugated proteins
- B1.2.12** Relationship of form and function in globular and fibrous proteins

STAGES OF TRANSLATION

Outline the process by which translation is initiated (including initiator tRNA and start codons)

Describe the role of ribosomal sites (A, P and E) in elongation and translocation



Outline the process by which translation is terminated (including releasing factors and stop codons)

DIRECTIONALITY

State the directionality of translation

PROTEIN FOLDING

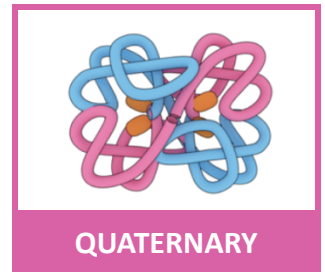
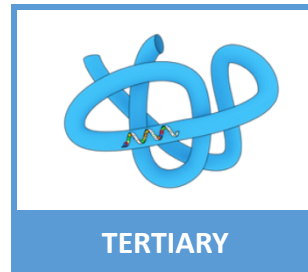
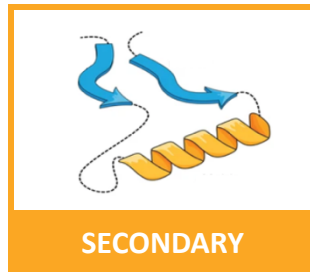
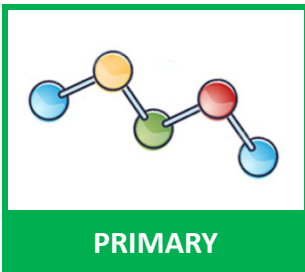
Outline the four levels of protein structure (including types of bonds and components involved in bonding)

Primary Structure:

Secondary Structure:

Tertiary Structure:

Quaternary Structure:



TYPES OF PROTEINS

Distinguish between the structure and function of fibrous and globular proteins

Fibrous:

Globular:

PROTEIN PROPERTIES

Describe the effect of polar and non-polar amino acids on the tertiary structure of proteins

Cytosolic Proteins:

Transmembrane:

PROTEIN MODIFICATIONS

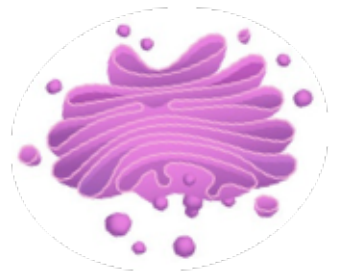
Identify types of protein modification

Describe the two-stage modification of pre-proinsulin to insulin

1. _____
2. _____

PROTEIN DESTINATIONS

Distinguish between the synthesis of intracellular and extracellular proteins



PROTEIN DEGRADATION

Describe the role of ubiquitin and proteasomes in the breakdown of proteins and recycling of amino acids

4.6 – EPIGENETICS (AHL)

- D2.2.1 Gene expression as the mechanism by which information in genes has effects on a phenotype
- D2.2.2 Regulation of transcription by proteins that bind to specific base sequences in DNA
- D2.2.3 Control of the degradation of mRNA as a means of regulating translation
- D2.2.4 Epigenesis as the development of patterns of differentiation in cells of a multicellular organism
- D2.2.5 Differences between the genome, transcriptome and proteome of individual cells
- D2.2.6 Methylation of the promoter and histones in nucleosomes as examples of epigenetic tags
- D2.2.7 Epigenetic inheritance through heritable changes to gene expression
- D2.2.8 Examples of environmental effects on gene expression in cells and organisms
- D2.2.9 Consequences of removal of most but not all epigenetic tags from the ovum and sperm
- D2.2.10 Monozygotic twin studies
- D2.2.11 External factors impacting the pattern of gene expression

GENE EXPRESSION

Differentiate between the genome, transcriptome and proteome

Genome	
Transcriptome	
Proteome	

Identify the mechanisms by which gene expression can be regulated

1. _____
2. _____
3. _____
4. _____



EPIGENESIS

Define epigenesis and outline the impact of epigenetic changes on genotype and phenotype

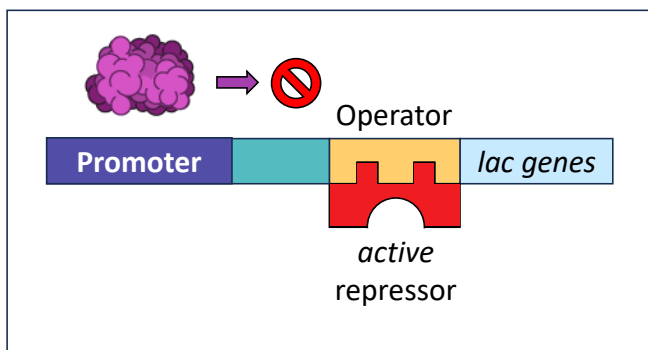
TRANSCRIPTION FACTORS

Explain how transcription factors impact gene expression (including the role of enhancer / silencer sites)

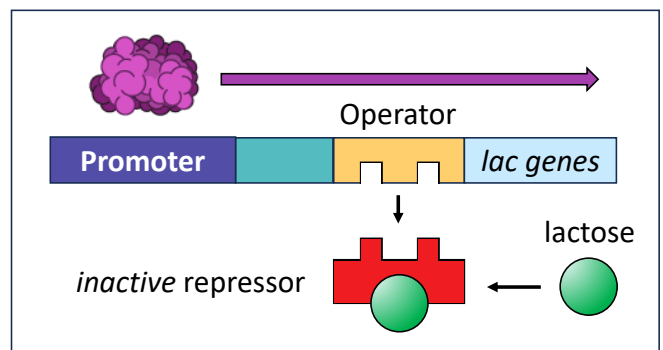
Outline examples of how external factors can regulate gene expression by acting on transcription factors

Steroid Hormone:

Inducer (Lactose):



Gene Expression (no lactose)

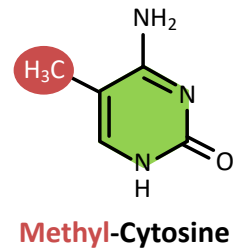


Gene Suppression (lactose present)

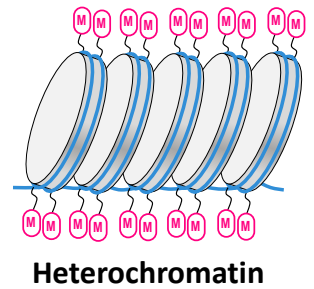
METHYLATION

Outline the function of methylation as an epigenetic tag

DNA Methylation:



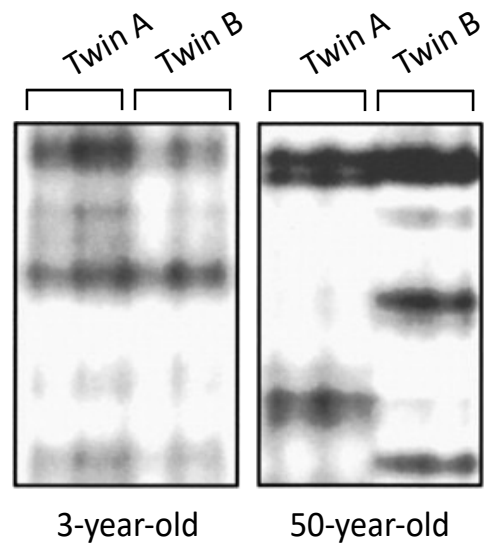
Histone Methylation:



ENVIRONMENTAL EFFECTS

Outline the impact of air pollution on the epigenetic regulation of genes involved in the immune response

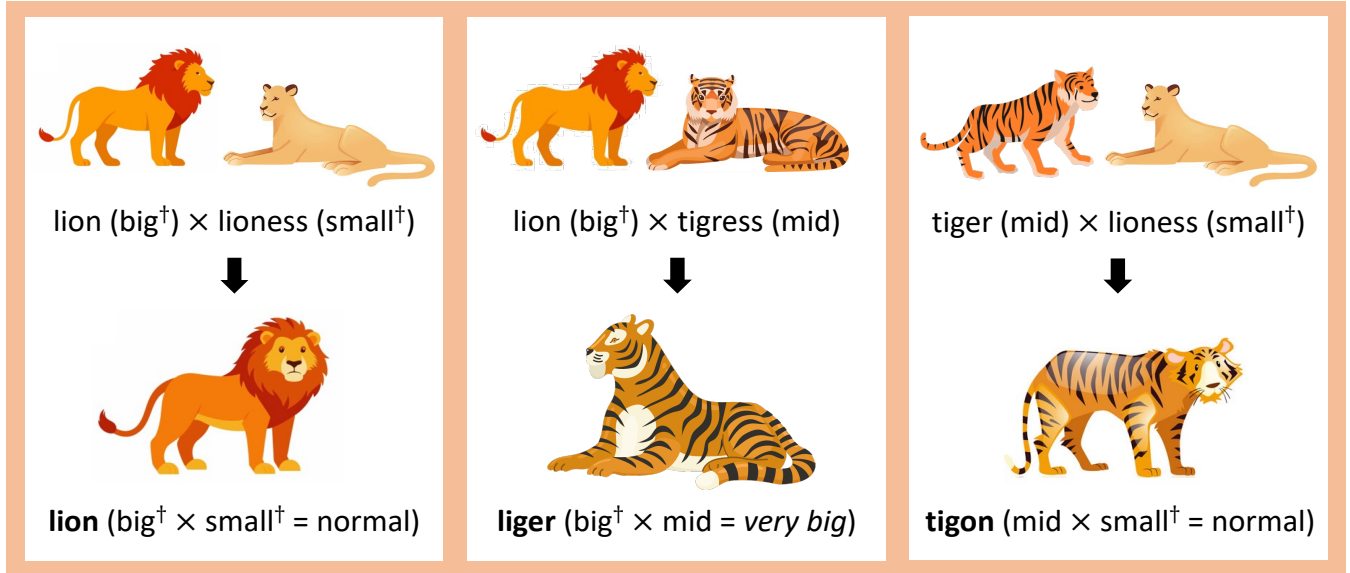
Explain why monozygotic twin studies are used to measure environmental impacts on gene expression



EPIGENETIC INHERITANCE

Describe how genomic imprinting may occur within offspring

Outline the epigenetic causes for the differences in size between tigons and ligers (lion-tiger hybrids)



RNA DEGRADATION

Outline how the degradation of mRNA is controlled as a mechanism of regulating translation
