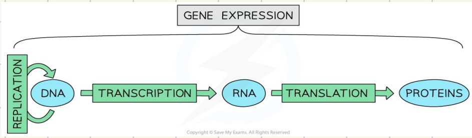
D2.2.1 — Gene expression & phenotype



Stages of gene expression
1. Transcription
2. Translation
3. Protein function

D2.2.2 — Regulation of transcription

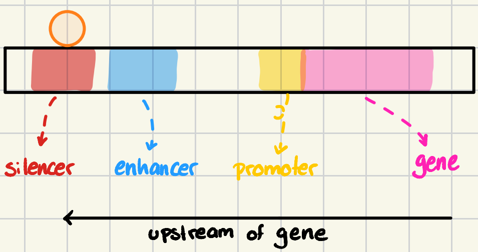
Promotor => area/ base sequence where RNA polymerase binds to begin transcription

Transcription factor => DNA binding protein that controls transcription by binding to enhancer/silencer/ promoter

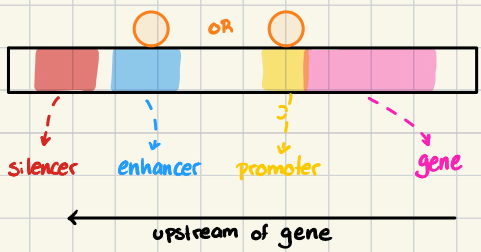
Enhancer => base sequence that promotes transcription when transcription factor binds there

Silencer => base sequence that inhibits transcription when transcription factor binds there

gene ≠ expressed



gene = expressed



D2.2.3 — Regulating translation

- Mature mRNA includes poly-A tail
  - Tail shortens/degrades @ varying degrees over time
  - mRNA molecules w/ shorter tails = less likely to be translated bc they = vulnerable to degradation by **nuclease enzymes**
    - By changing Poly-A tail => cell controls how much protein is made using that mRNA
- Can be affected by hormones

D2.2.4 — Epigenesis

Epigenesis => stem cells differentiate into dif. tissues in multicellular organisms (process)

> The development of differentiation patterns in the cells of multicellular organisms as it develops from a zygote

↳ Differentiation happens when some genes are activated & others are silenced

Epigenetic tags => chemical modifications that cause some genes to be activated & others to be silenced

↳ Does not affect genes themselves, just the pattern of expression

Epigenetics => genetic control by factors other than an individual's DNA sequence

These can be acquired through life

D2.2.5 — genome, transcriptome, proteome

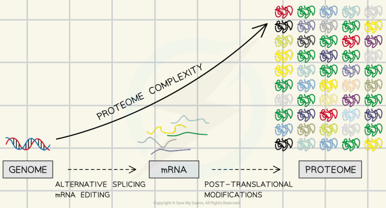
Genome => all the genetic info. in cell

Transcriptome => all the mRNA sequences in a cell

Proteome => all the proteins produced by a cell

} varies for individuals bc cells do not transcribe all genes all the time

depends on what the cell needs @ specific times



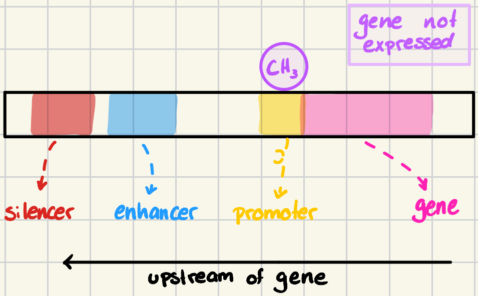
D2.2.6 — Epigenetic tags

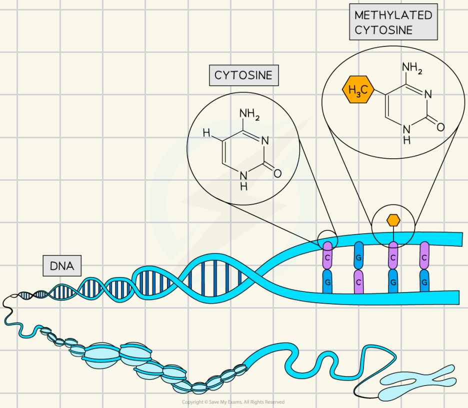
Methylation => a type of epigenetic tag that involves addition of methyl group (to DNA or histone proteins)

↳ Methylation of promoter region of gene inhibits transcription

↳ can change how available DNA is to transcription factors

- when CH_3 binds to histones, it "squishes" proteins together compromising RNA polymerase's ability





D2.2.7 — Epigenetic inheritance

Epigenome => all of the epigenetic tags in an organism

↳ Daughter cells of mitosis receive the genome & epigenome of parent cell

- **Ex. => Neuron**
  1. Neuron undergoes mitosis
  2. daughter cells get genome & epigenetic tags that tell cells what genes to suppress
     i) genes suppressed = those which correspond to blood cell, cardiac cells, etc.
  3. This allows daughter cells to look & function like neuron

Epigenetic inheritance => inheritance of epigenetic tags

↳ Both in mitosis —daughter cells— and meiosis —gametes— produced cells will inherit epigenome

In meiosis, however, some tags are removed.
↳ "reprograming of genome"
↳ "clean slate"

D2.2.8 — Environmental effects

↳ Factors in the environment can change the pattern of genetic expression

- **Ex. => Air pollution decreases DNA methylation**
  a) More gene transcription
  b) More immune system proteins produced [Genes that get commonly unmethylated]
     i. Asthma
     ii. Heart attack
     iii. gestation

D2.2.9 — Consequences of removing epigenetic tags from ovum & sperm

Genomic imprinting => when epigenetic tags remain on DNA during gamete formation & are passed to offspring

↳ Can disrupt typical genetic inheritance if dominant allele = silenced by imprinting

~~A~~A

aa

	a	a
~~A~~	~~A~~a	~~A~~a
A	Aa	Aa

In every scenario, dominant trait from dad should be expressed... but it might not be, as it was silenced with dad's genome & passed on

Ex. => Lions

↳ Female lions can carry offspring from multiple males @ same time

- Females => advantage = having lots of cubs
  - Imprinting for large litters
- Males => advantage = having biggest cub
  - Imprinting for large offspring

} usually evens out

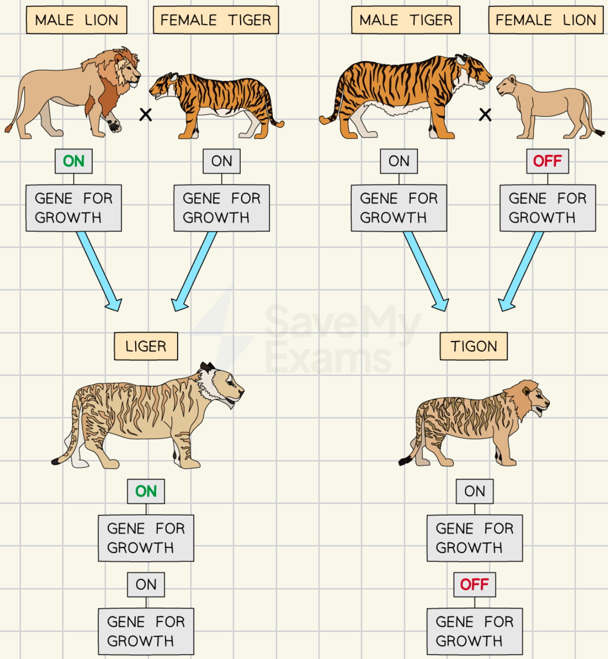
↳ Tigers & lions can interbreed

- female tigers can only carry a litter from single male @ a time
  - No imprinting necessary in male tigers
  - Their cubs don't need to compete w/ other male's cubs

male tiger + Female lion = small

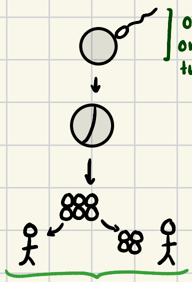
vs.

male lion + female tiger = large

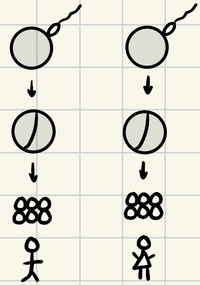


D2.2.10 — Monozygotic twin studies

monozygotic (twins) vs. **Dizygotic** (twins)



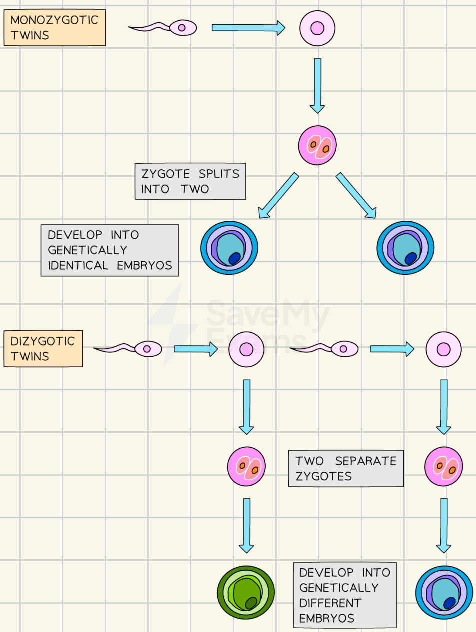
one egg, one sperm, two **IDENTICAL**



two eggs, two sperm, two **NONIDENTICAL** kids

Monozygotic twins = valuable for research bc. they have same genome (DNA) but acquire dif. epigenetic tags throughout lifetime.

Nature vs. nurture
↓ genome ↓ epigenetic tags

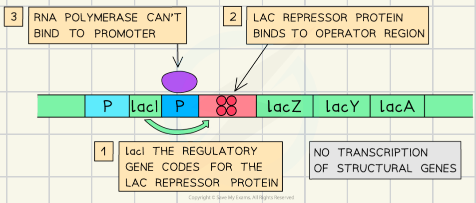


D2.2.11 — External factors

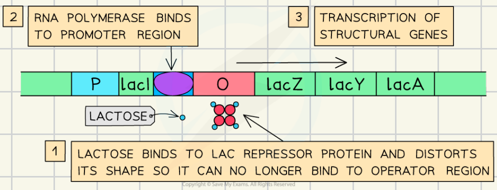
↳ Lactose = example of a **biochemical factor** that impacts gene expression

- Lactase gene is normally silenced
  - when lactose levels rise, repressor protein = deactivated & gene = expressed
  - when lactose levels fall, repressor protein reactivates & silences gene (no more lactase)

Lactose absent



Lactose present



↳ Oestrogen = example of **hormonal factor** that influences pattern of gene expression

- Hormone that binds to target genes & changes their expression
  - Can bind to gene coding for progesterone receptors in the endometrium
    1. Oestrogen turns on this gene
    2. Progesterone receptors = produced
    3. Tissue becomes more responsive to progesterone

} 1 hormone impacting effect of another