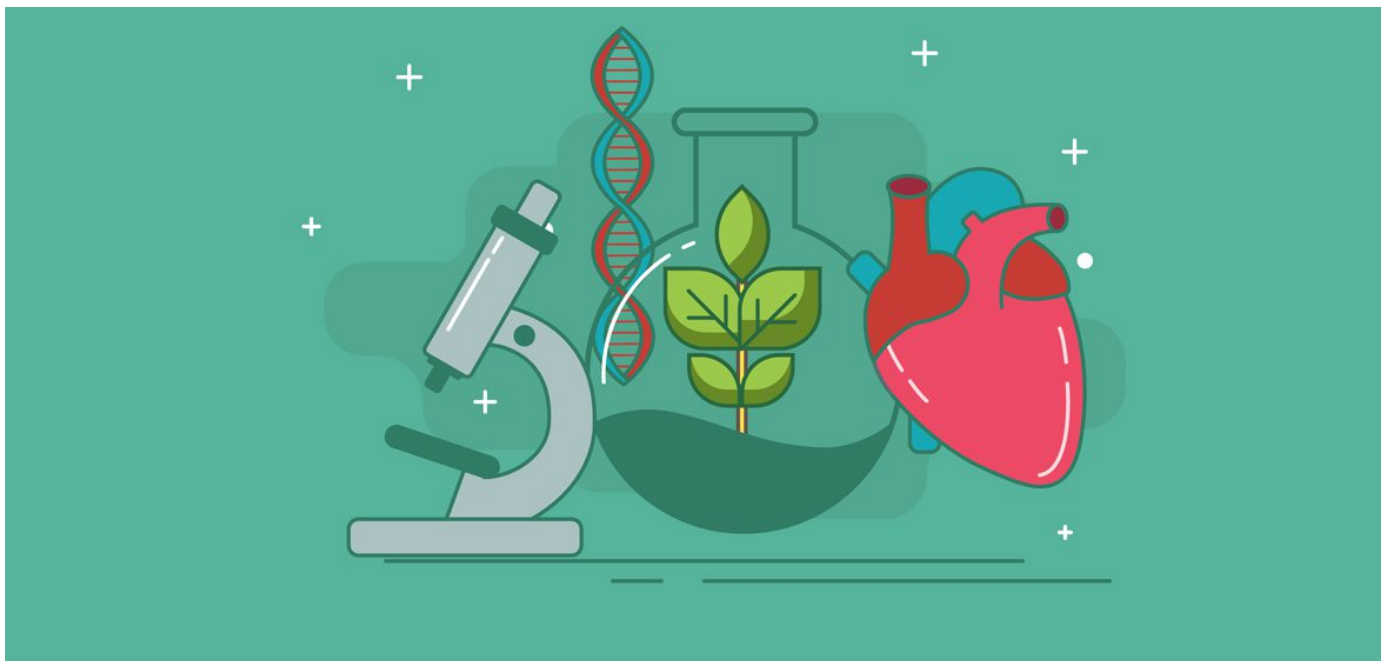# HSC Biology

Powerpoint slides

HSC 2020

NSW Department of Education

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2020 HSC Study Day Series

AURORA COLLEGE

Details

Date:	Wednesday 1st July, 2020
Time:	8:50am – 3:10 pm
Location:	Adobe Connect room https://connect.schools.nsw.edu.au/aurora-hsc-study2/
Materials:	Available to download via this Dropbox link
Recordings:	The sessions will be recorded and accessible for registered participants after the event via the same Dropbox link above. These recordings will be accessible until the HSC exam.

Program

Time	Session
8:50 – 9:00 am	**Welcome**
9:00 – 9:40 am	**Moving up a mark range / Exam tips** *Dr Silvia Rudmann, Gorokan HS & Aurora College*
9:45 – 10:45 am	**Module 5 – Heredity** *Tim Sloane, Head Teacher Science, Concord High School*
10:45 – 11:15 am	Morning tea break
11:15 – 12:15 pm	**Module 6 – Genetic Change** *Tim Sloane, Head Teacher Science, Concord High School*
12:20 – 1:20 pm	**Module 7 – Infectious Disease** *Dr Silvia Rudmann, Gorokan HS & Aurora College*
1:20 – 2:00 pm	Lunch break
2:00 – 3:00 pm	**Module 8 – Non-infection disease and disorders** *Dr Silvia Rudmann, Gorokan HS & Aurora College*
3:00 – 3:10 pm	**Conclusion**

2020 HSC Study Day Series

Setting up Adobe Connect

Teachers will need:

- A good, stable Dept of Ed internet connection using an ethernet cable (wifi not recommended)
- Data projector
- Speakers

The sessions will be held via Adobe Connect. Please ensure there is only one connection per school. The presentation can be displayed on a data projector through any computer with an ethernet cable and speakers. The information below will help with setting up if you are not familiar with Adobe Connect.

- You will need to perform all necessary setup in advance of your online session so that you have time to resolve any connection or access issues. The Adobe room will be opened 30 mins prior to commencing to allow time for set up.

- Test your computer prior to accessing your online room by going to the Meeting Connection Diagnostic. Ensure you install any add-ins, if prompted to do so by the connection test.

- The following guide may also be useful Quick Start Guide for Participants.

Entering the Adobe room

Teachers log in once for their class. Students are NOT to log in individually. To enter your online room, click on the Adobe Connect link provided above. Enter by typing in your Department of Education ID (eg: *jane.citizen@detnsw)* in the *Username* field then your DoE password in the *Password* field. The first thing you should do when you enter the room is complete the audio setup wizard. ('Meeting' drop down menu-> Audio Setup Wizard)

For technical help:

If you are having any issues with technology, please contact the Aurora College IT Support Team on 1300 610 733 or support@aurora.nsw.edu.au

Rights and responsibilities

Duty of care for students throughout the day remains with the registered schools and their respective teachers. Please ensure adequate supervision is provided during the day. Respectful and active participation in the event is strongly encouraged through the 'chat' pod.

Evaluation

Constructive feedback is essential, links to online surveys will also be distributed during and shortly after the event. There are two surveys and they both close on 21st September:

- Teachers https://www.surveymonkey.com/r/HSCSTUDYDAYSTEACHER2020
- Students https://www.surveymonkey.com/r/HSCSTUDYDAYSSTUDENT2020

We look forward to your participation.

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IGNITING NEW WAYS OF LEARNING

HSC Study day – Biology Session
'Moving up to reach that Band 6'

Dr Silvia Rudmann

silvia.rudmann@det.nsw.edu.au

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Overview

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Before the exam:
- ✔ Outcomes and content
- ✔ Exam requirements
- ✔ Simple study skills for Biology
- ✔ Identify the verbs from the syllabus
- ✔ 'Build up' those verbs across the same concept
- ✔ Annotated diagrams and graphs

During the exam
- ✔ Don't panic! Think!
- ✔ What the markers will expect in your answers

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Biology exam requirements

Content
- Content statements
- Inquiry questions
- Year 11 content is assumed knowledge

Working scientific
- Questioning and predicting
- Planning, conducting investigations
- Processing and analysing data
- Problem solving
- Communication

Applications
- Agriculture
- Vaccines
- Pharmaceuticals
- Control and prevention
- Technologies

Ethics
- Technologies
- Laws
- Aboriginal protocols
- Society believes
- Bias

Study skills

Traffic light strategy

to double check the learnt content:

Highlight the syllabus content statements and inquiry questions.

I don't know about this

I am not sure about this

I know about this

23/06/2020

Study skills

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Sit down and study

Practice from previous exams

Answer the inquiry questions

Draw all models and diagrams

Study and learn the verbs

Concept maps

Learn Biology as a story of building up concepts

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Study skills

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Get organised with your study:

· Create a concept map to link concepts, skills and investigations
· Summarise an answer for each inquiry question
· Summarise each content statement
· Use tables and flow charts to link processes and content
· Create an investigation scaffold for each investigation
· Colour coded concepts, skills, investigations and verbs
· Create a study timetable

3

Learn the syllabus

Module 5: Heredity
Outcomes

- **A student:**
- selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media BIO11/12-4
- analyses and evaluates primary and secondary data and information BIO11/12-5
- solves scientific problems using primary and secondary data, critical thinking skills and scientific processes BIO11/12-6
- explains the structures of DNA and analyses the mechanisms of inheritance and how processes of reproduction ensure continuity of species BIO12-12

Skills, knowledge and understanding is applied to learn the content

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Learn the syllabus

Module 5: Heredity
Content
Reproduction
Inquiry question: How does reproduction ensure the continuity of a species?

Students:
- explain the mechanisms of reproduction that ensure the continuity of a species, by analysing sexual and asexual methods of reproduction in a variety of organisms, including but not limited to:
    – animals: advantages of external and internal fertilisation
    – plants: asexual and sexual reproduction
    – fungi: budding, spores
    – bacteria: binary fission (ACSBL075)
    – protists: binary fission, budding

Topics to learn during the course

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Learn the syllabus

- The Year 12 Biology syllabus is not created to be learnt and studied linearly.
- Concepts are integrated and overlapped.
- Differences in terminology:
  - For example, ….
  - Including …..
  - Included but not limited to…

Learn ONE example well but know about the others too

Learn EVERYTHING for that content statement

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Learn the syllabus

Inquiry question: How does reproduction ensure the continuity of a species?

Students:

- explain the mechanisms of reproduction that ensure the continuity of a species, by analysing sexual and asexual methods of reproduction in a variety of organisms, including but not limited to:
  - animals: advantages of external and internal fertilisation
  - plants: asexual and sexual reproduction
  - fungi: budding, spores
  - bacteria: binary fission (ACSBL075)
  - protists: binary fission, budding
- analyse the features of fertilisation, implantation and hormonal control of pregnancy and birth in mammals (ACSBL075)
- evaluate the impact of scientific knowledge on the manipulation of plant and animal reproduction in agriculture (ACSBL074)

Content to be used as evidence to answer the inquiry question

Syllabus verbs

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List of
verbs
from
the
syllabus

Investigate	Explain	Conduct	Assess
Explain	Plan	Construct	Evaluate
Analyse	Interpret	Describe	Design
Distinguish	Compare	Model	Classify

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Syllabus verbs

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Terms commonly used in exams

- Critically
- Synthesised
- Recommend
- Propose
- Predict
- Extrapolate
- Extract
- Annotate
- Discuss
- Deduce
- Calculate
- Clarify
- Appreciate
- Apply

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Syllabus verbs – build up

Describe	Explain	Analyse	Assess
• Characteristics	• Cause and effect	• Relationship and implications between components	• Make a judgement of value
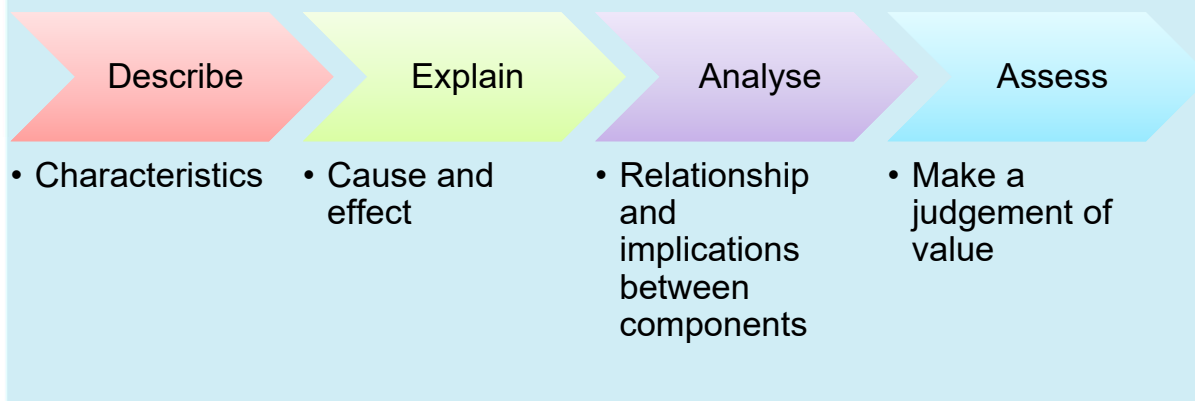
Syllabus verbs – build up

Content – protein synthesis

Describe
Protein synthesis is the process in which the DNA is transcribed and translated into a polypeptide chain.

Explain
Protein synthesis is the process in which the DNA is transcribed in the nucleus to a single strand of mRNA. In that process, the T nucleotide is replaced by a U nucleotide. The mRNA leaves the nucleus and join ribosomes in where it will be translated into a polypeptide chain. In the process of translation, the tRNA will bring anticodons…..
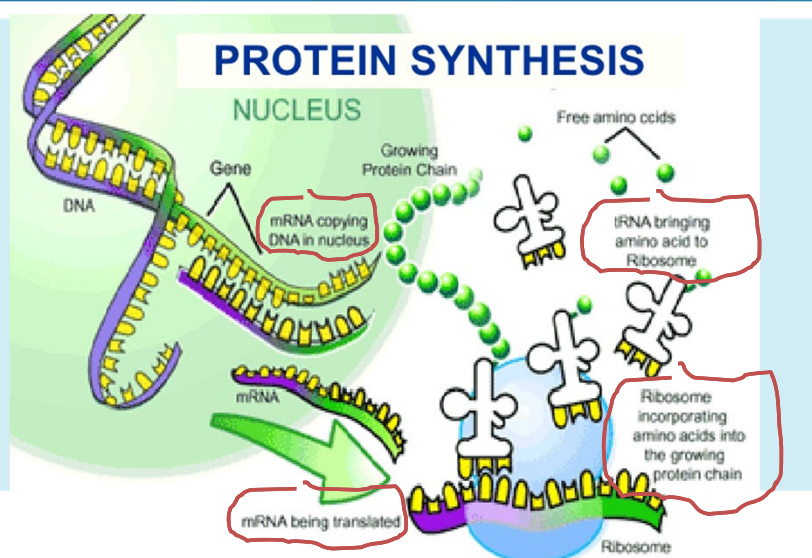
Syllabus verbs – build up

Analyse

In the process of protein synthesis, the relationship between DNA, mRNA and tRNA is crucial to produce the proteins needed in the metabolism. The DNA is transcribed in the nucleus by the mRNA which leaves the nucleus and takes the genetic information to the ribosome in which the tRNA will translate it using anticodons to a polypeptide chain.

Assess

The process of protein synthesis is important for the metabolic functions of every organism. Because any changes in this process will affect the function of metabolic pathways since in those pathways enzymes, proteins, hormones are used…….
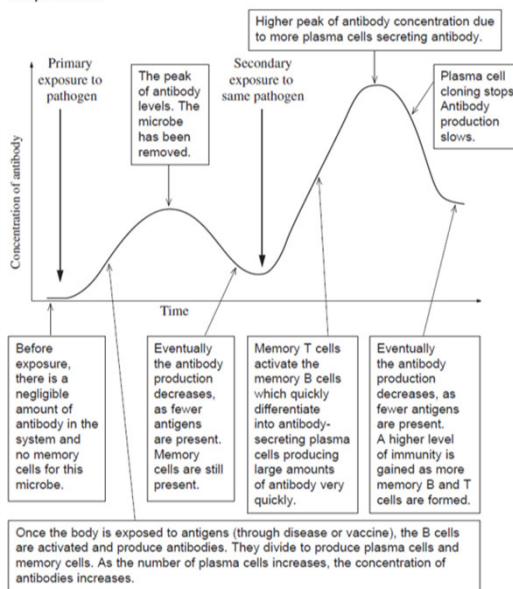
Models/diagrams

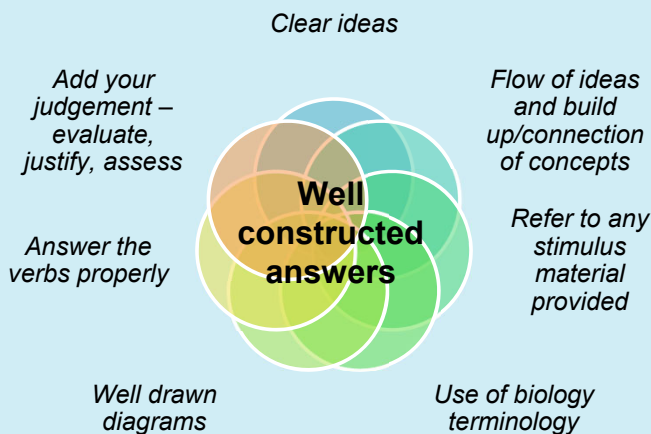Model/diagram labelled and/or annotated – with simple explanations

Graphs

annotated graphs – with detailed explanations

Sample answer:

Primary exposure to pathogen

The peak of antibody levels. The microbe has been removed.

Secondary exposure to same pathogen

Higher peak of antibody concentration due to more plasma cells secreting antibody.

Plasma cell cloning stops. Antibody production slows.

Concentration of antibody

Time

Before exposure, there is a negligible amount of antibody in the system and no memory cells for this microbe.

Eventually the antibody production decreases, as fewer antigens are present. Memory cells are still present.

Memory T cells activate the memory B cells which quickly differentiate into antibody-secreting plasma cells producing large amounts of antibody very quickly.

Eventually the antibody production decreases, as fewer antigens are present. A higher level of immunity is gained as more memory B and T cells are formed.

Once the body is exposed to antigens (through disease or vaccine), the B cells are activated and produce antibodies. They divide to produce plasma cells and memory cells. As the number of plasma cells increases, the concentration of antibodies increases.

Expectations from the marker

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Clear ideas

Add your judgement – evaluate, justify, assess

Flow of ideas and build up/connection of concepts

Well constructed answers

Answer the verbs properly

Refer to any stimulus material provided

Well drawn diagrams

Use of biology terminology

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Band descriptors – Band 6

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- demonstrates an extensive knowledge and understanding of scientific concepts, including complex and abstract ideas
- communicates scientific understanding succinctly, logically, and consistently using correct and precise scientific terms and application of nomenclature in a variety of formats and wide range of contexts
- designs and plans investigations to obtain accurate, reliable, valid and relevant primary and secondary data, evaluating risks, mitigating where applicable, and making modifications in response to new evidence
- selects, processes, and interprets accurate, reliable, valid, and relevant qualitative and quantitative, primary or secondary data, and represents it using a range of scientific formats to derive trends, show patterns and relationships, explain phenomena, and make predictions
- designs solutions to scientific problems, questions, or hypotheses using selected accurate, reliable, valid, and relevant primary and secondary data, and scientific evidence, by applying processes, modelling and formats
- applies knowledge and information to unfamiliar situations to propose comprehensive solutions or explanations for scientific issues or scenarios

Band descriptors – Band 6

AURORA
COLLEGE

- demonstrates an **extensive** knowledge and understanding of scientific concepts, including complex and abstract ideas
- communicates scientific understanding **succinctly, logically**, and consistently using correct and **precise scientific terms** and application of nomenclature in a variety of formats and wide range of contexts
- designs and plans investigations to obtain **accurate, reliable, valid** and relevant primary and secondary data, **evaluating risks**, mitigating where applicable, and making modifications in response to **new evidence**
- selects, processes, and interprets accurate, reliable, valid, and relevant qualitative and quantitative, primary or secondary data, and represents it using a range of scientific formats to **derive trends, show patterns and relationships, explain phenomena, and make predictions**
- **designs solutions to scientific problems, questions, or hypotheses** using selected accurate, reliable, valid, and relevant primary and secondary data, and scientific evidence, by applying processes, modelling and formats
- **applies knowledge** and information to **unfamiliar** situations to propose **comprehensive** solutions or explanations for scientific issues or scenarios

Band descriptors – reaching that Band 6

At Band 6

extensive

thorough

effective

logically

succinctly

At Band 3-4

Sound

Recall

Basic

Band descriptors – reaching that Band 6

④

Sound
Effective

Scientific
concepts and
skills are basic.
Recall information
Use scientific
terms and
nomenclature

→

⑤

Thorough
Logically and effective

Scientific concepts and
skills are integrated using
complex and abstract
ideas.
Explanations for scientific
issues or scenarios.

→

⑥

Extensive
Succinctly, logically and
consistently

Scientific concepts and skills
are integrated and correlated
using complex and abstract
ideas.
Comprehensive solutions for
scientific issues or
scenarios.

Exam skills

| Reading time | Multiple choices – take time, don't rush | Extended responses – flow chart of ideas | Don't leave unanswered questions – have a go | Revise |
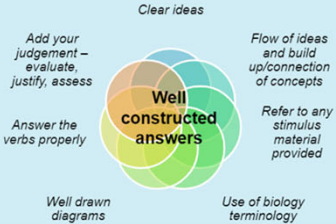
Expectations from the marker - examples

Clear ideas

Add your judgement – evaluate, justify, assess

Flow of ideas and build up/connection of concepts

Answer the verbs properly

Well constructed answers

Refer to any stimulus material provided

Well drawn diagrams

Use of biology terminology

(b) During your study of this option, you were required to construct a model of DNA.

(i) Describe the model you constructed. 3

(ii) Justify the design of your model. 3

Expectations from the marker - examples

AURORA COLLEGE

Clear ideas

Add your judgement – evaluate, justify, assess

Flow of ideas and build up of concepts

Well constructed answers

Answer the verbs properly

Good Biology

Well drawn diagrams

Use of biology terminology
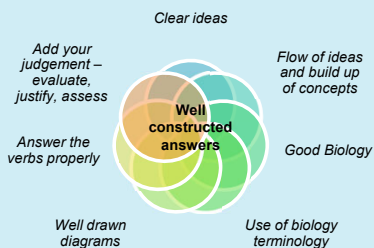
Band?

Question 30 (b) (i)

Outcomes assessed: H9, H11, H13

MARKING GUIDELINES

Criteria	Marks
• Detailed description of model with molecular components correctly identified	3
• Description of model incomplete or with some aspects of molecular components absent or oversimplified	1–2

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Expectations from the marker - examples

AURORA COLLEGE

Clear ideas

Add your judgement – evaluate, justify, assess

Flow of ideas and build up of concepts

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Good Biology

Well drawn diagrams
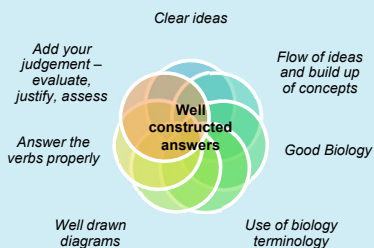
Use of biology terminology
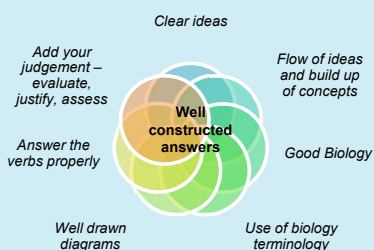
Mark?

b)i) Model of DNA was constructed using cardboard shapes to represent the four nitrogenous bases as well as the deoxyribose and the phosphate backbone. This model was much larger than actual DNA That is, an adenine was shaped to match with a cardboard thymine, and cytosine matched guanine These nitrogenous bases were in turn joined onto a hexagon (sugar) and then to a rectangle (phosphate) After cutting out the pieces and sticking them together in a ladder-like formation, the model was twisted around to mimic the helical nature of the DNA molecule.

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Expectations from the marker - examples

AURORA COLLEGE

Clear ideas

Add your judgement – evaluate, justify, assess

Flow of ideas and build up of concepts

Well constructed answers

Answer the verbs properly

Good Biology

Well drawn diagrams
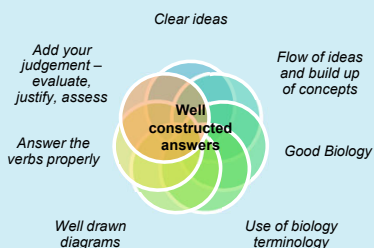
Use of biology terminology

Band?

Question 24 (4 marks)

Traditionally, banana plants in Australia have been propagated asexually by cutting out and planting suckers from the adult plant.

4

Sucker — Banana plant
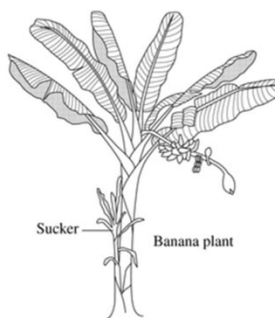
There is a growing trend to produce disease-free plants in laboratories through a process of cloning from disease-free tissues from existing plants.

Assess the potential impact of this cloning process on the genetic diversity of banana plants in Australia.
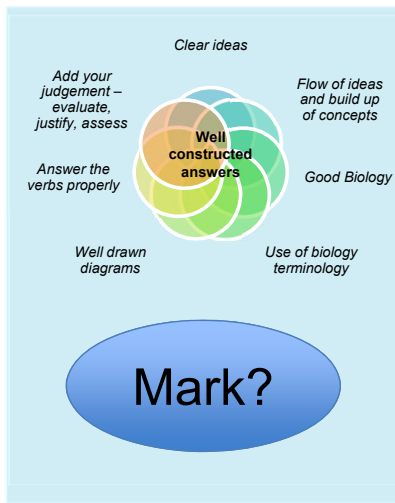
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Expectations from the marker - examples

AURORA COLLEGE

Clear ideas

Add your judgement – evaluate, justify, assess

Flow of ideas and build up of concepts

Well constructed answers

Answer the verbs properly

Good Biology

Well drawn diagrams

Use of biology terminology

Band?

MARKING GUIDELINES

Criteria	Marks
• Relationship between cloning and reduced genetic diversity identified	3–4
• Recognises that there is no potential impact in this situation	
• Relationship between cloning and reduced genetic diversity identified	1–2

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Expectations from the marker - examples

Clear ideas

Add your judgement – evaluate, justify, assess

Flow of ideas and build up of concepts

Answer the verbs properly

Well constructed answers

Good Biology

Well drawn diagrams

Use of biology terminology

Mark?

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Assess the potential impact of this cloning process on the genetic diversity of banana plants in Australia.

Although cloning would mean an innital increase in the production of bannana's due to the increased health of the plants the impact on the genetic diversity of banana plants in Australia could be potentially disaterous. If all banana plants became cloned from a disease-free plant it would mean less variation within the species and if a particular disease developed that could not be detected by the plants then ~~~~ all the plants face developing the disease.

General resources

- *Useful websites for resources to study and revise*
-
- Khan academy – https://www.khanacademy.org/science/biology
- Khan academy app for android and iphone
- Learn genetics – https://learn.genetics.utah.edu/
- Biology corner – https://www.biologycorner.com/
- HHMI Biointeractives - https://www.biointeractive.org/
- World Health Organisation (WHO) – https://www.who.int/
- Conquer Biology Notes - https://www.conquerhsc.com/hsc-biology-syllabus-notes/
- NESA – Biology - https://educationstandards.nsw.edu.au/wps/portal/nesa/11-12/stage-6-learning-areas/stage-6-science/biology-2017

it
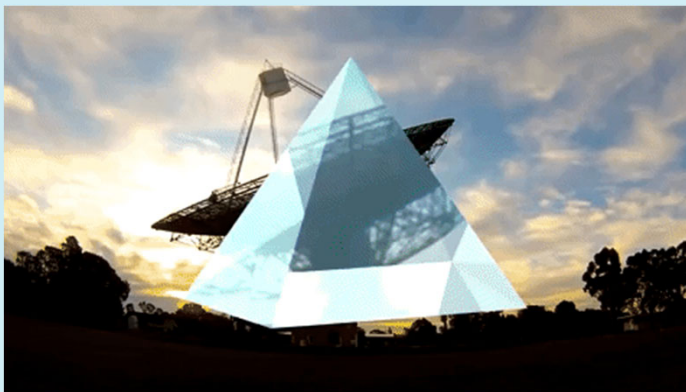Always
seems
impossible
until it's
Done.

- Nelson Mandela -

You are
capable of
AMAZING
things.

You have brains in your head.
You have feet in your shoes.
You can steer yourself
in any direction you choose!
-DR SEUSS

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Good luck!

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ANY QUESTIONS?
? ? Who
How ? ? Where Why

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Module 5
HEREDITY

Inquiry question 1
How does reproduction ensure the continuation of species?

Outcome 12.1a.

Explain the mechanisms of reproduction that ensure the continuity of a species, by analysing sexual **and** asexual methods of reproduction in a variety of organisms, **including but not limited to**:
- plants: asexual and sexual reproduction
- fungi: budding, spores
- bacteria: binary fission
- protists: binary fission, budding
- animals: advantages of external and internal fertilisation

Asexual and sexual reproduction

Asexual reproduction: offspring that are genetically identical to a single parent.

Sexual reproduction: occurs when two parents contribute genetic information to produce unique offspring.

In terms of continuity of species
Advantages and disadvantages of both which is why some organisms do both!

All offspring are identical UNLESS mutation occurs

All offspring are genetically different
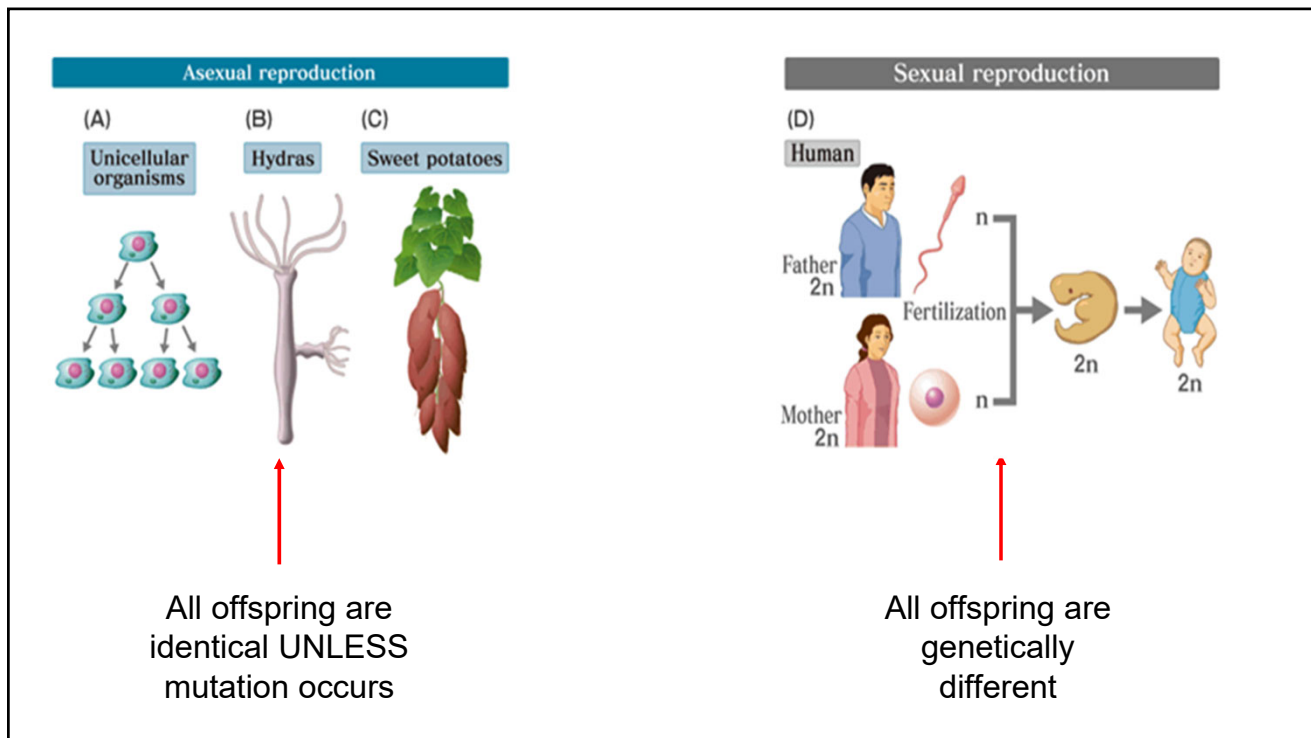
- **Explain** = Find the **cause and effect** relationship of each point under the outcome heading

- **Cause**: Define the terms: sexual reproduction, asexual reproduction, internal fertilisation, external fertilisation, continuity of species etc

- **Effect**: give an explanation/how/why does each method of reproduction ensures continuity of species
  - must make **clear links** as to how genetic information is passed on and whether the offspring will be genetically identical (asexual) or different to the parent (sexual)

- Where necessary show advantages and disadvantages for each type of reproduction with reference to survival of species

  - Need to directly relate to selective pressures
    - Water availability
    - Predators etc

Outcome 12.1b.

Analyse the features of fertilisation, implantation **and** hormonal control of pregnancy **and** birth in mammals

---

- **Define terms:** fertilisation, implantation and hormone, pregnancy and birth
- **Describe** characteristics of each process and the hormones involved
- **Explain** (give detailed reason) how specific hormones regulate each stage
- **Describe** trends in data given regarding changes in hormonal levels
  - Make direct reference to lines in graph (gradient of line to indicate the rate of change, peaks that may appear)
- Detail similarities and differences in the processes in **types of mammals**
  - Gestation periods
  - Development of young
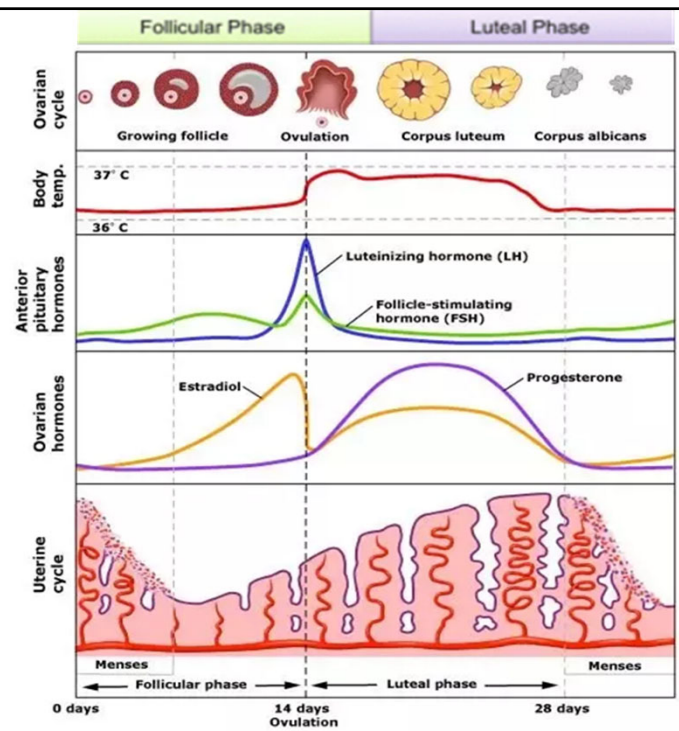
Outcome 12.1c.

evaluate the <u>impact of scientific knowledge</u> on the <u>manipulation of</u> plant **and** animal reproduction in agriculture
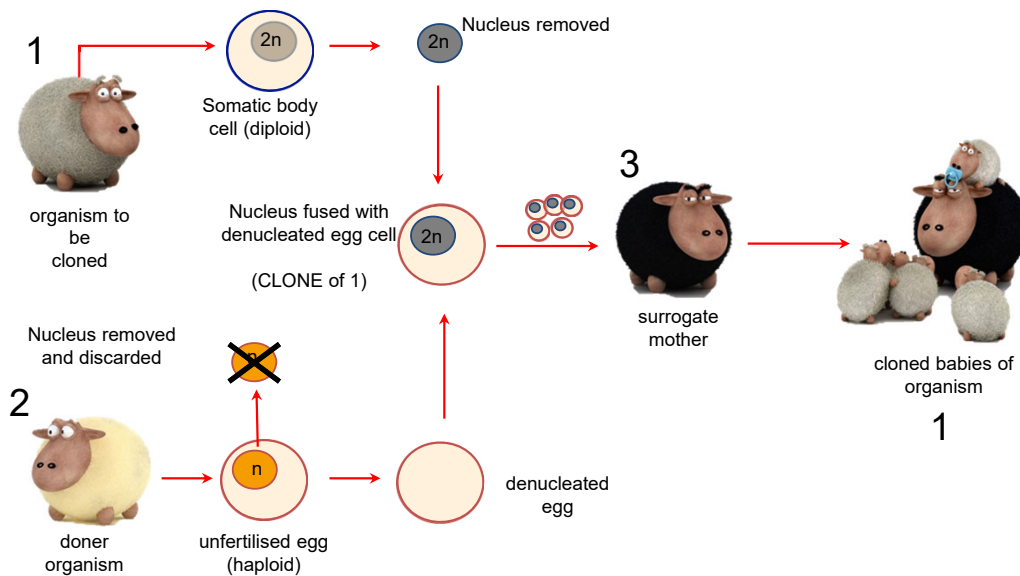

- Give definitions of the agriculture **AND** technologies that you will be discussing

- Give **descriptions** (features) of each type of technology (such as Artificial pollination, Artificial insemination, Cloning, Genetically Modified Organisms)

- **Explain**
  - how has each technology been used in agriculture in both plants **AND** animals and WHY it is used
  - The **scientific knowledge** needed to enable these technologies to be developed (relate back to types of reproduction and the processes involved)

- **Analyse-** include arguments FOR and AGAINST the use of these technologies. Make sure it is related to biology (biodiversity, survival of species etc)

- **Evaluate-** (THIS IS CRUCIAL TO QUALIFY FOR A BAND 6 RESPONSE)
  - **give a judgement** on the use of these technologies in agriculture-are these effective/successful technologies .
  - Back up your judgement with evidence (this evidence must come from analysis- NO NEW evidence should be introduced here)
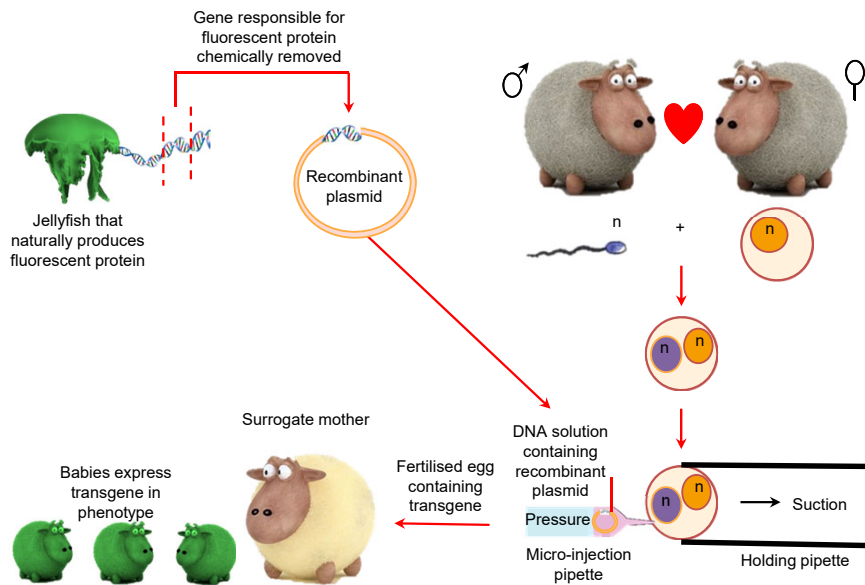
Plants: artificial pollination

Parent plant 1 Parent plant 2

Pollen transfer

1 To prevent self-fertilisation, the immature stamens are removed.

2 The carpel (egg producing structure wit pollen from another plant's mature stamens.

3 The carpel matures into a pod containing seeds. Once planted, these seeds grow into offspring plants.
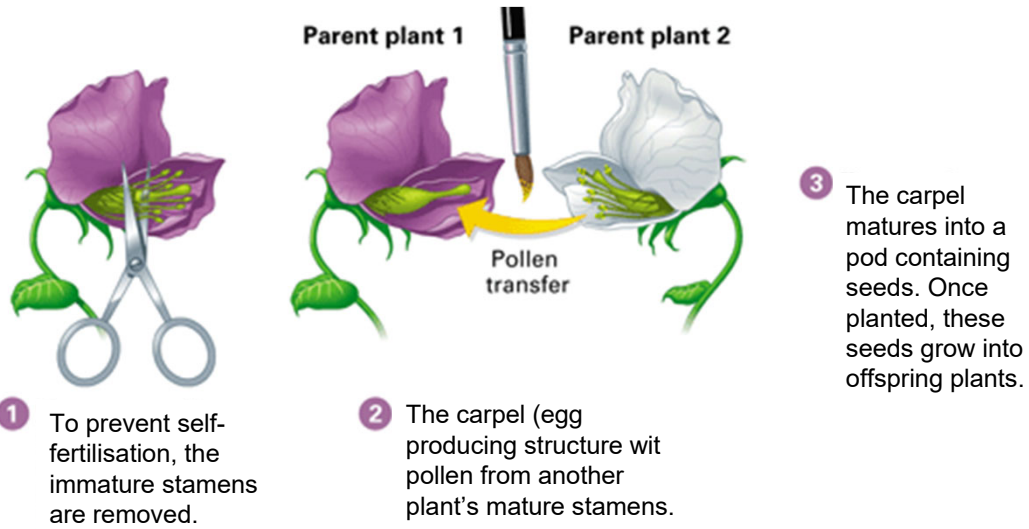
Animals and plants: Cloning

1

organism to be cloned

2n
Somatic body cell (diploid)

2n Nucleus removed

Nucleus fused with denucleated egg cell (CLONE of 1)

2n

3

surrogate mother

cloned babies of organism

1

Nucleus removed and discarded

2

doner organism

n
unfertilised egg (haploid)

denucleated egg

Animals and plants: Transgenic species

Selection of HSC questions from work booklet

Mod 5 – Question 1

A strawberry plant will send out over the ground runners which will take root and grow a new plant as shown.

This method of growing a new plant is an example of

A. budding.

B. germination.

C. external fertilisation.

D. asexual reproduction.

19 A zebronkey hybrid is the result of crossing a male zebra which has 44 chromosomes with a female donkey which has 62 chromosomes.

How many chromosomes will the zebronkey have?

A. 53

B. 75

C. 84

D. 106

11 Which of the following is an example of *hybridisation*?

(A) The insertion of a bacterial gene for herbicide resistance into a cotton plant

(B) The culturing of a cell taken from the root of a carrot to form a small plant

(C) Artificial insemination of a domestic cat with wild cat semen to produce a Bengal cat

(D) A cutting taken from one variety of apple tree grafted onto the stem of a different variety of apple tree

5   The gamete plays an important role in sexual reproduction because it carries

(A)   genetic information from both parents.

(B)   half the genetic information of the parent.

(C)   all of the genetic information of the parent.

(D)   double the genetic information of the parent.
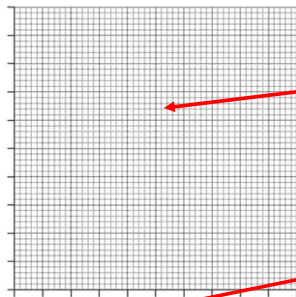
Mod 5 – Question 11 (6 marks)

(a)   The following data shows the average amount of Human Chorionic Gonadotropin   **3**
        (hCG) produced by pregnant women.

Correctly label y-axis (**dependent variable**)

Weeks of pregnancy	hCG (ng/mL)
0	0
4	85
8	185
12	185
16	80
20	65
24	60
28	65
32	75
36	65
40	35

Use the information provided to graph the levels of hCG in a normal pregnancy.

Include a title

Should be a line graph as there is a direct relationship between the time (weeks in pregnancy) and the amount of hormone released

Correctly label x-axis (**independent variable**)
Ensure units of measure are correct and increments evenly spaced (both x and y axis)
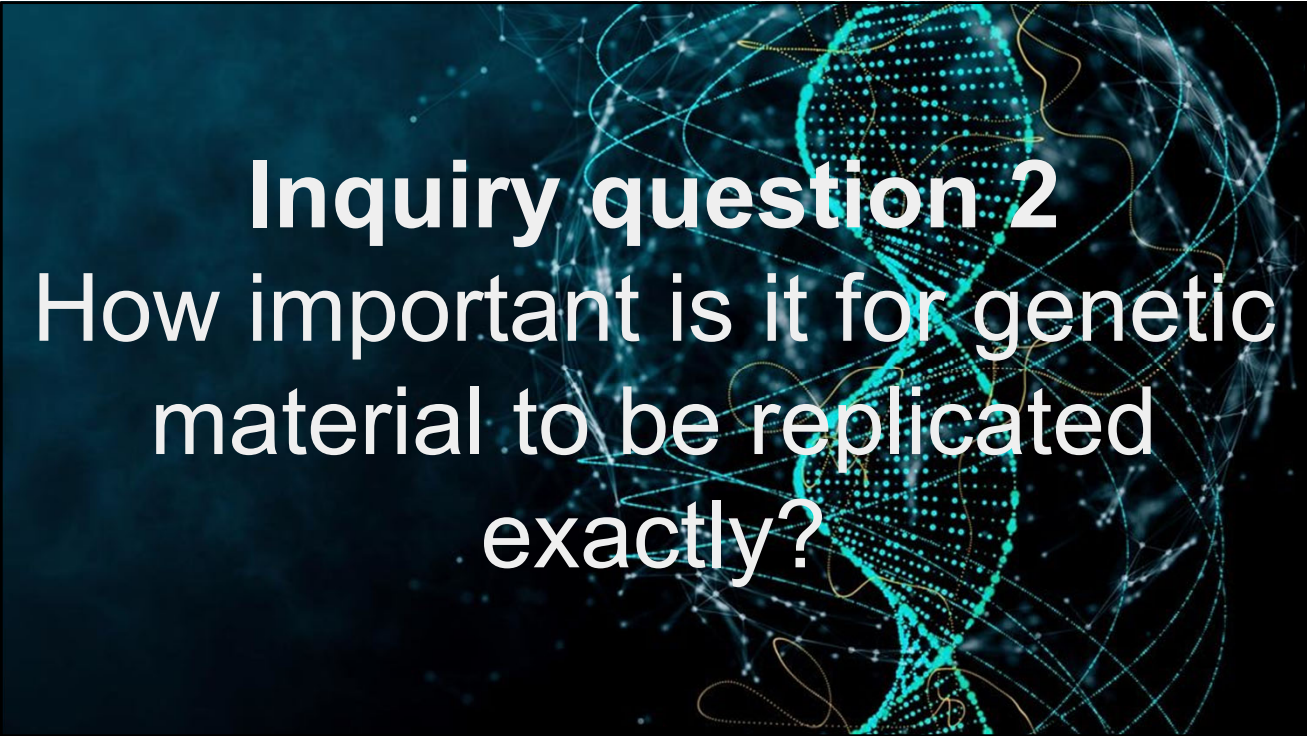
Question 11 (continued)

(b)   Describe the role and changes in levels of a hormone in pregnancy.   3

What does the hormone hCG do and how does it change
- Human chorionic gonadotropin
- Maintains corpus luteum, allowing it to secrete progesterone
- Changes need to be **related directly to graph-** mention how shape of graph changes as levels change (are the changes fast, slow, steady)

Inquiry question 2
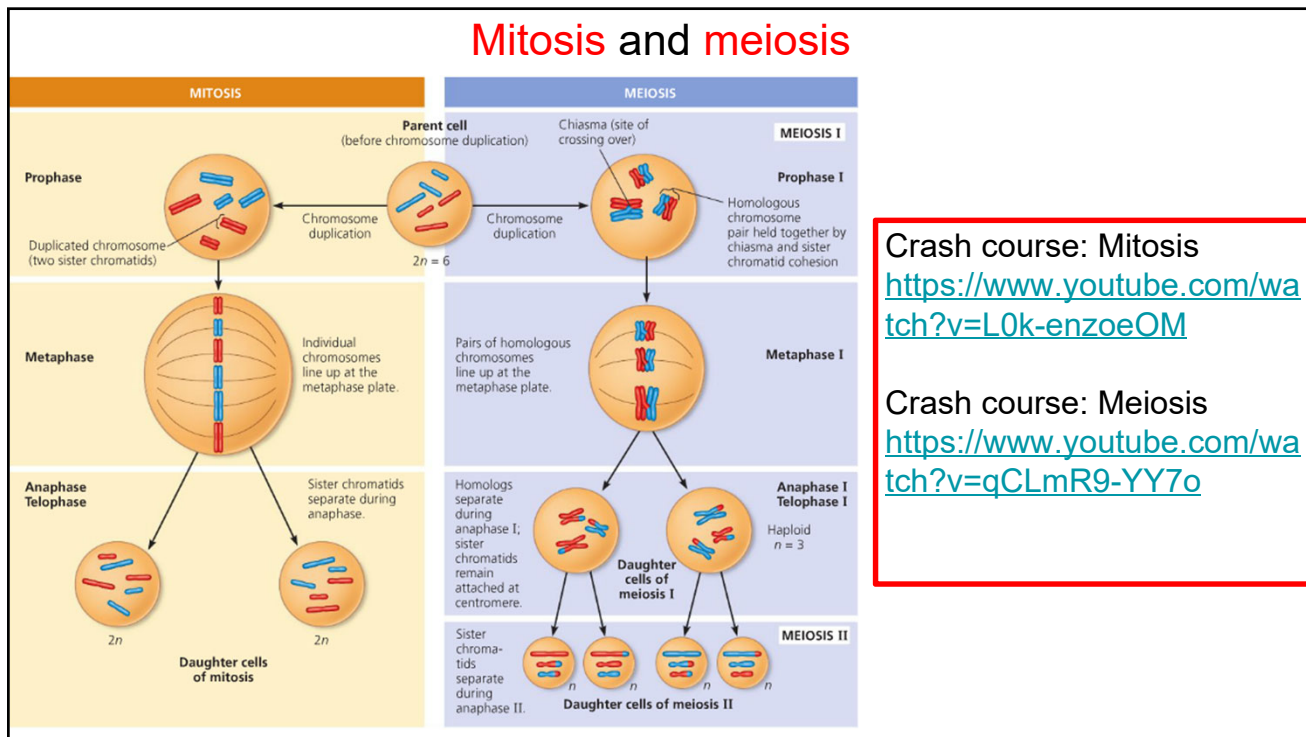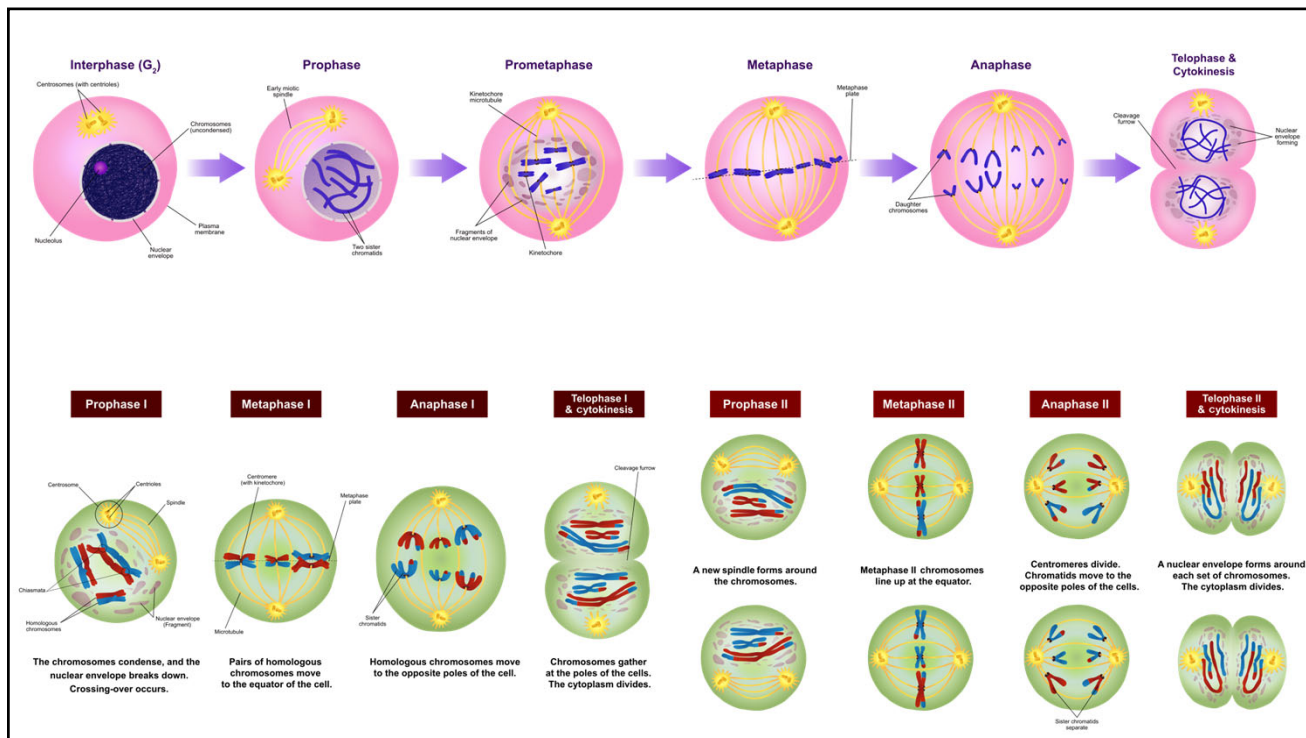How important is it for genetic material to be replicated exactly?

Outcome 12.2a.

Model the processes involved in cell replication, **including but not limited to**:
- mitosis **and** meiosis
- DNA replication using the <u>Watson and Crick DNA model</u>, including <u>nucleotide composition</u>, <u>pairing and bonding</u>

Model the processes involved in cell replication:

- **Create a model-** this can be physical (construction, <u>diagrammatical</u>), conceptual (principals, laws and theories), mathematical (equations and data)

- In an exam you may be asked to evaluate a model OR relate steps of a given model to processes occurring in meiosis or mitosis

- **annotate models** to explain each biological process.

- If asked for a **flowchart** include **arrow<u>s</u>** between each diagram to show the correct sequence of events. Label each step and give a short description of what is occurring at each step (make direct reference to the changes in the shape and number of chromosomes)
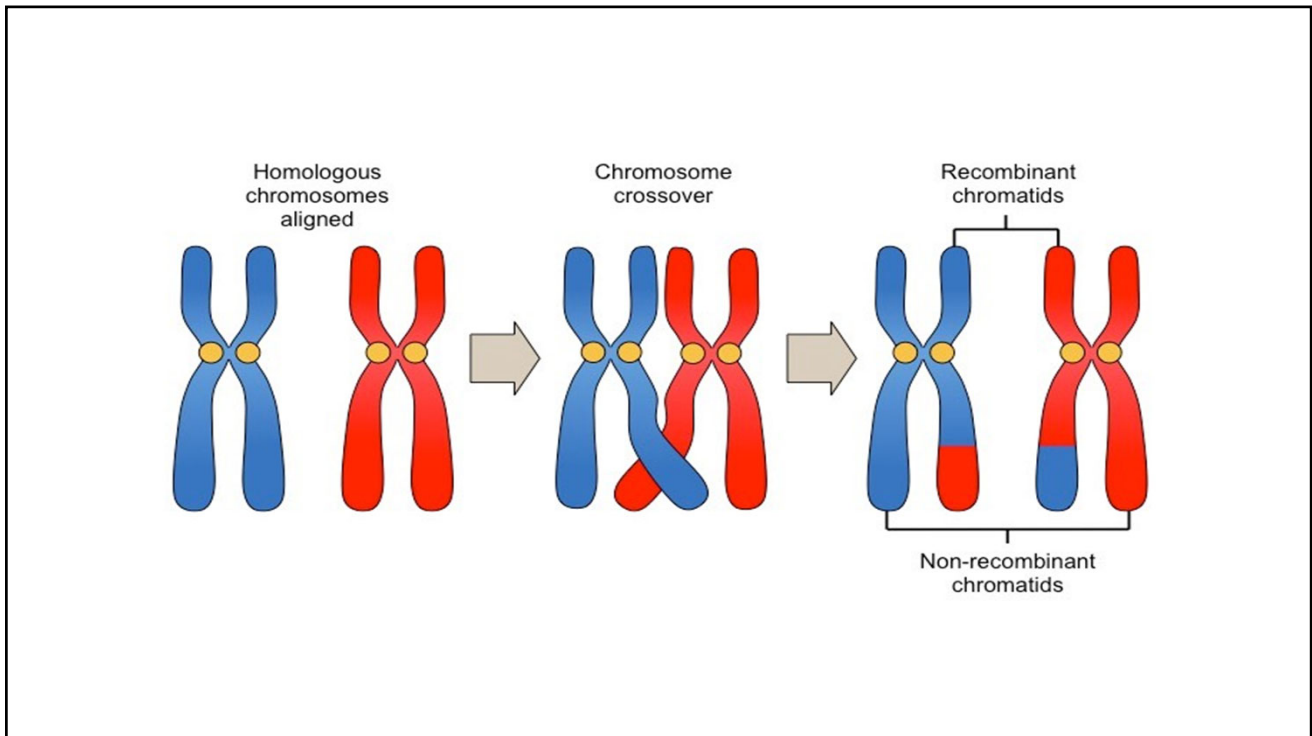
Mitosis and meiosis

Crash course: Mitosis
https://www.youtube.com/watch?v=L0k-enzoeOM

Crash course: Meiosis
https://www.youtube.com/watch?v=qCLmR9-YY7o

Outcome 12.2b.

Assess the <u>effect of</u> the cell replication processes on the <u>continuity of species</u>

- **Identify** processes involved in cell replication

- **Define** mitosis, meiosis **and** continuation of species

- **Describe** features of processes involved in cell replication

- **Explain** how processes of cell replication result in copying of genetic information AND the potential introduction of variation in offspring

- **Explain** the advantages **and** disadvantages of each type of cell replication for continuation of a species

- **Give a judgement** regarding the importance of cell replication for continuity of species

Homologous chromosomes aligned

Chromosome crossover

Recombinant chromatids

Non-recombinant chromatids

Selection of HSC questions from work booklet

13 A section of DNA has the following nucleotide sequence.

AGG TCT CAG ATC

What is the nucleotide sequence of the newly-made strand following DNA replication?
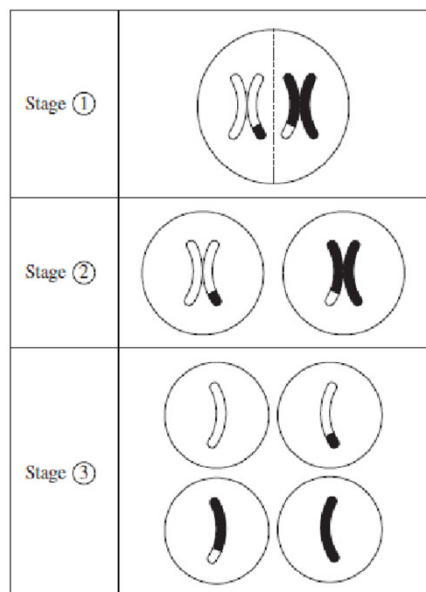
A. AGG TCT CAG ATC
B. AGG UCU CAG AUC
C. UCC AGA GUC UAG
D. TCC AGA GTC TAG

7 Thirty percent (30%) of the nucleotide bases in human DNA are adenine (A).

What is the percentage of guanine (G) bases in human DNA?

(A) 20%
(B) 30%
(C) 40%
(D) 70%

Refer to the following information to answer Questions 13 and 14.

The diagram shows some chromosomes during some stages of meiosis.

13 When does the segregation of homologous chromosomes occur?

(A) Before stage ①
(B) Between stages ① and ②
(C) Between stages ② and ③
(D) Between stages ① and ② and again between stages ② and ③

14 The chromosomes shown carry

(A) different genes and different alleles.
(B) different genes and the same alleles.
(C) the same genes and different alleles.
(D) the same genes and the same alleles.

Question 23 (3 marks)

The diagram shows a model involving DNA.
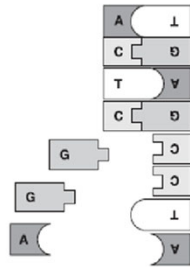
Only base pairing modelled

(a) What process is being modelled?   **1**

....

(b) Identify TWO structural features of the DNA molecule which are NOT shown in this model.   **2**

....

....

....

....

Nucleotide composition not shown

Does not show DNA as being a double helix

Question 29 (5 marks)

Scientists have tried to achieve a viable embryo by fusing two ova (eggs) from the same female.   **5**

Explain whether the offspring produced using this process would be a clone of the female whose two ova were used. Use your knowledge of gamete formation and sexual reproduction to support your answer.

Need to address whether offspring will be a clone - need a <u>statement</u> with justification. Commit to offspring not being a clone
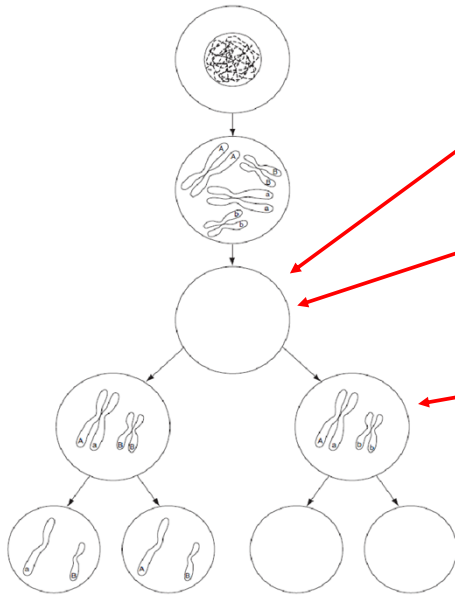
Two processes to address- describe each process AND address how each process results in variation of gametes/embryo

MODELS/diagrams can be used here to support your answer

Need to show cause and effect relationship

Question 29 (5 marks)

(a) Complete the following diagram to show the process by which gametes are formed.   3

Ensure sister chromatids are joined at centromere.

Ensure you engage with stimulus and check where crossing over has occurred.

Important that allele combinations are taken from relevant M1 daughter cell.

Question 28 (6 marks)

(a) Explain how ONE named process that occurs during meiosis results in genetic variation.   3

....

....

....

....

ONE = ONE (CO, IN, RS)

Explain = cause and effect

As a result of ………..

Inquiry question 3
Why is polypeptide synthesis important?

Outcome 12.3a.

Construct appropriate representations to **model** and **compare** the forms in which DNA exists in eukaryotes and prokaryotes

DNA structure

Nucleoid
Chromosomal DNA
Single, circular, double stranded piece of DNA. No histone proteins. Not surrounded by a nuclear membrane

Plasmid
Independent DNA molecule
Small circular, independent double stranded DNA molecule. Plasmids can frequently be transmitted from one bacterium to another

Nuclear DNA
Chromosomal DNA
Always linear, double stranded and in nucleus. Wrapped around histone proteins. No plasmids.

(a)

DNA

mRNA

5′

Growing amino acid chain

PROKARYOTE

(b)

DNA — Nucleus

Transcription and processing

5′ — 3′
Processing
5′ — 3′

Transport

5′ — 3′

Cytoplasm

mRNA

EUKARYOTE

Outcome 12.3b.

Model the process of polypeptide synthesis, including:
- transcription **and** translation
- **assessing** the importance of mRNA **and** tRNA in transcription **and** translation
- **analysing** the <u>function and importance of polypeptide synthesis</u>
- **assessing** how <u>genes **and** environment affect phenotypic expression</u>

- Create a model- usually a diagrammatical flowchart showing steps of polypeptide synthesis (flow charts must contain more than 2 arrows)

- **annotate models** to **describe** the main steps of transcription and translation

- **define** the terms mRNA and tRNA

- **describe** the structure and function of mRNA and tRNA

- clearly **explain** the roles of
  - mRNA during transcription
  - tRNA during translation

- **explicit judgement** regarding the importance of correct functioning of tRNA and mRNA in the production of polypeptides (band 6)

Transcription and translation
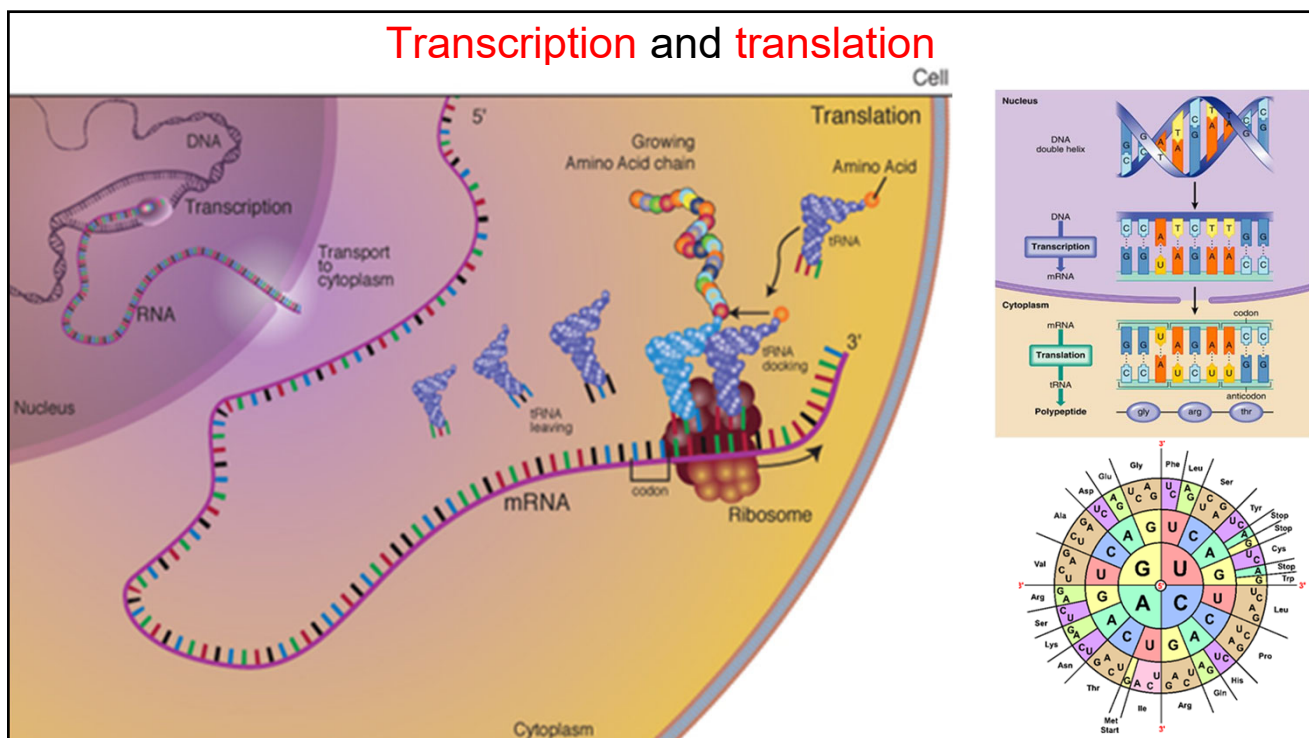
Analysing the function **and** importance of polypeptide synthesis

- **Identify** the mains steps involved in polypeptide synthesis and the location of each step

- **Define AND describe** the steps involved in polypeptide synthesis (transcription and translation) - can be done in a flowchart

- **Explain** the **function** of polypeptide synthesis

- **Explain** the **importance** of polypeptide synthesis

- **Discuss**, with examples, the effects of mistakes that may occur during polypeptide synthesis (mutations) - positive and negative effects

---

Analysing the function **and** importance of polypeptide synthesis

	NORMAL DNA	POINT MUTATION
Base sequence in DNA template strand	G C T T A T A A A T C C T A G / C G A A T A T T T A G G A T C	G C T T A T A A A T C C T A G / C G A A T T T T T A G G A T C
TRANSCRIPTION (copying)		
Base sequence in mRNA	G C U U A U A A A U C C U A G	G C U U A A A A A U C C U A G
TRANSLATION (change language)		
Amino acid sequence in polypeptide	Ala Tyr Lys Ser STOP	Ala STOP
	Functional enzyme	Non-functional enzyme
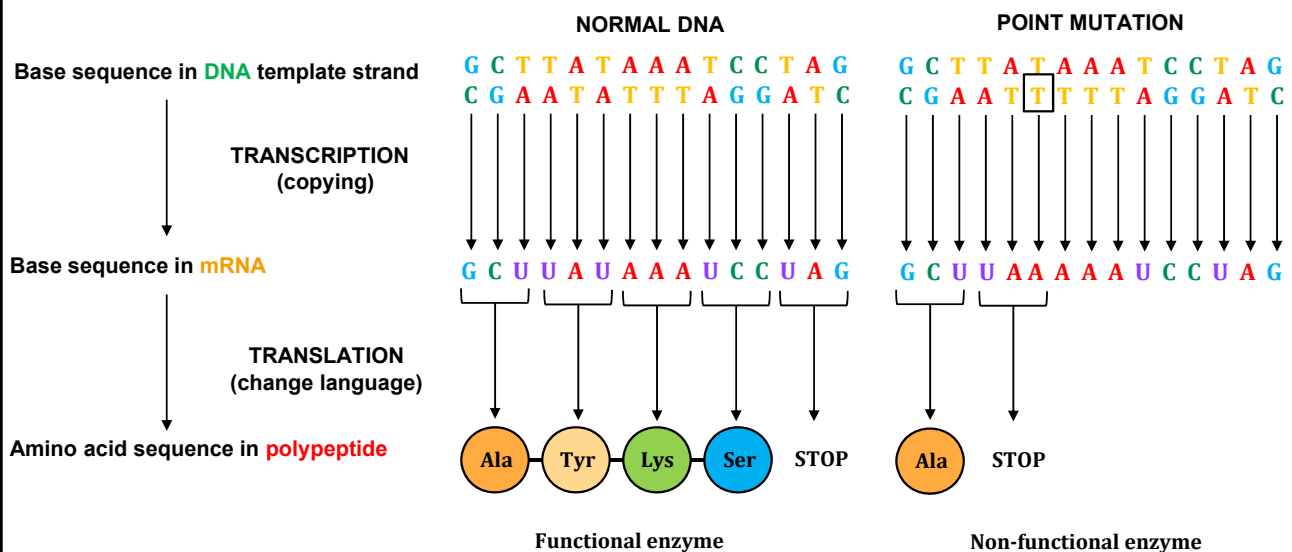
Effect of genes **and** environment on phenotypic expression

Gene expression is the process by which information from a gene is used in the synthesis of a functional gene product (protein).

The expression of genes can be influenced by the environment, including the external world in which the organism is located or develops, as well as the organism's internal environment, which includes factors such as hormones and metabolism.

GENES + ENVIRONMENT = PHENOTYPE

Note:
- Not all phenotypes are affected by environmental factors. Blood type
- Differences in phenotype caused by environmental factors are not passed from one generation to the next.

Effect of genes **and** environment on phenotypic expression

WORTH A VISIT:
These poignant portraits of Chinese twins show how once-identical siblings have changed almost beyond recognition over time.
Photographer and artist Gao Rongguo, from Binzhou in China's Shandong province, wanted to show the impact life has on our faces and bodies.

He chose twins who are all over 50 and pictured them facing one another as though they are looking at their reflection in a mirror. The images demonstrate how the twins have taken different paths through life and how their physical appearance has changed over the years.

Portraits of identical twins:
http://www.dailymail.co.uk/news/article-3533524/The-twins-identical-Poignant-portraits-Chinese-siblings-time-changed-recognition.html

Effect of genes **and** environment on phenotypic expression

Egg laying
0 days

28 days

Thermosensitive
period

52 days

Hatching
75–80 days

Indifferent
gonads

Expression or repression
of Sox9 gene

Male or
female
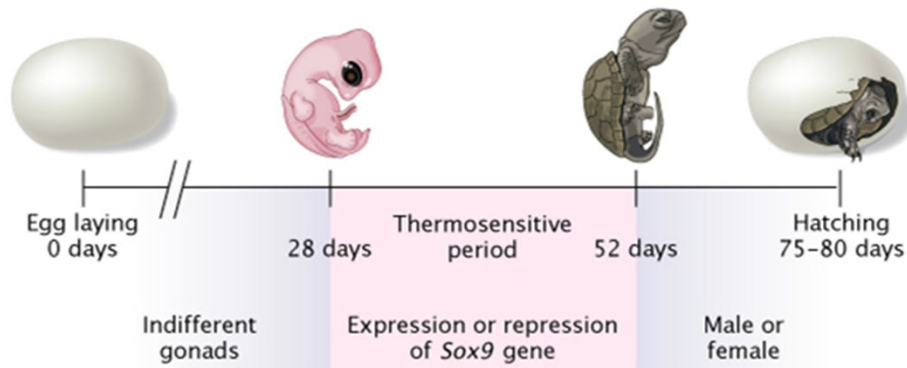
Example: the turtle Emys obicularis: at incubation temperatures of 25°C, all turtles are born male, but at temperatures of 30°C, all are born female

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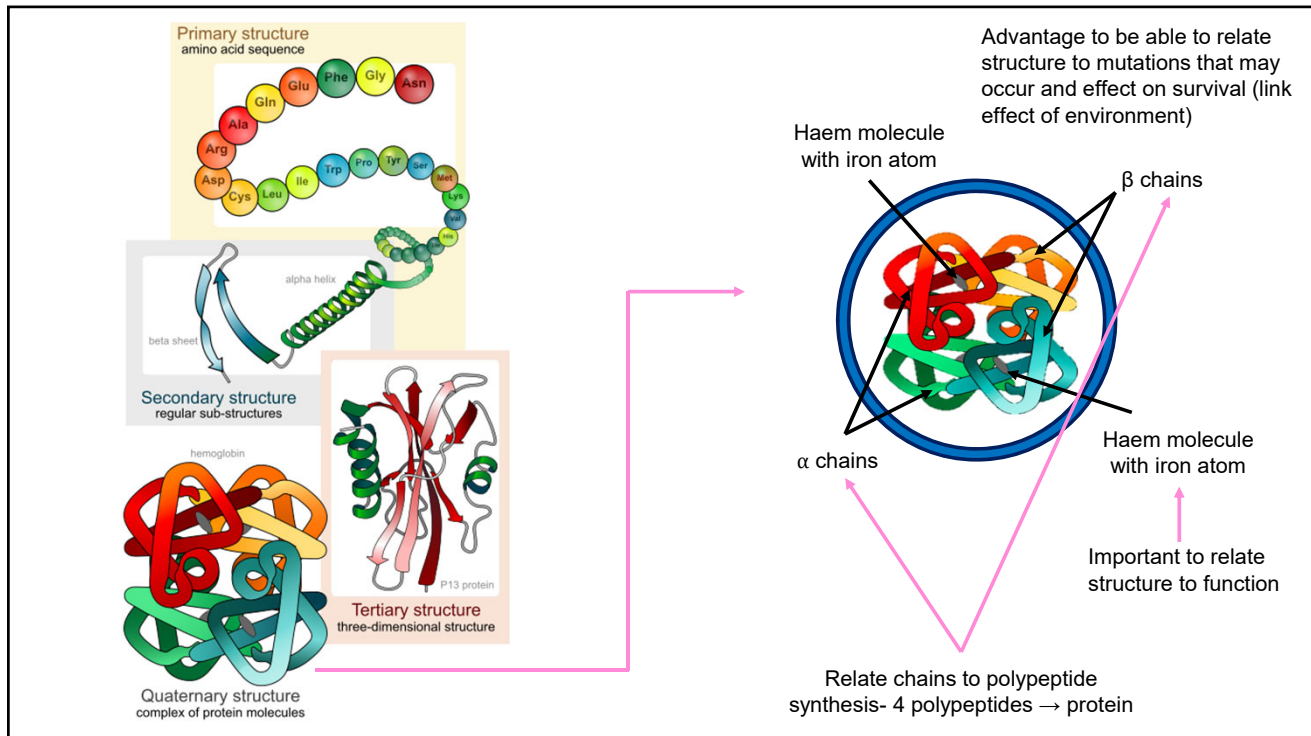Assessing how genes and environment affect phenotypic expression

- Define terms gene, gene expression, phenotype, transcription, translation
- Describe the process by which polypeptides are made
- Describe the factors that control gene expression in eukaryotic cells
- Use examples to show how genes can control the expression of proteins
- Use specific examples to show how the environment can affect the expression of proteins
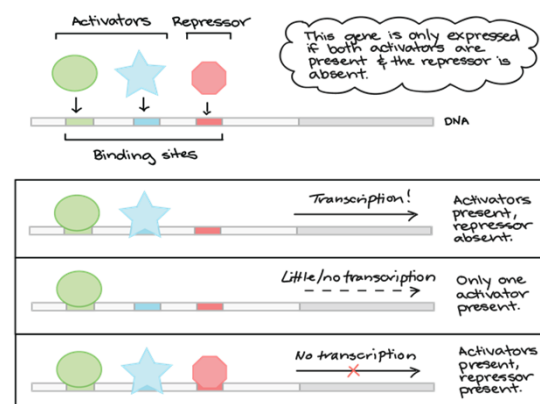
Outcome 12.3c.

investigate the <u>structure</u> and <u>function</u> of proteins in <u>living things</u>

- describe the structure of proteins
    - you may use models/diagrams to support this. Ensure that you refer to polypeptides

- describe the functions of proteins

- relate the structure of specific proteins to their functions
    - e.g. haemoglobin - comprised of 4 polypeptide chains (2 alpha and 2 beta chains). Include all main features. Relate these features to their function.
    - extension of this could have you relate mutations to the altered structure and function of specific proteins such as haemoglobin (sickle cell anaemia) - link to IQ in module 6

Primary structure
amino acid sequence

Secondary structure
regular sub-structures

hemoglobin

Tertiary structure
three-dimensional structure

Quaternary structure
complex of protein molecules

Advantage to be able to relate structure to mutations that may occur and effect on survival (link effect of environment)

Haem molecule with iron atom

β chains

α chains

Haem molecule with iron atom

Important to relate structure to function

Relate chains to polypeptide synthesis- 4 polypeptides → protein

---

Examples of proteins

3 groups: **structural proteins, protein hormones and enzymes.**

Structural protein: e.g. haemoglobin, found in RBC and binds oxygen. Collagen which is found in the bones, cells and skin. Provides strength to cellular structure.

Peptide hormones: e.g. insulin which helps you regulate blood sugar after a meal. Glucagon, another blood sugar-regulating hormone, is also a peptide.

All enzymes are proteins: e.g. lipase: essential role in the digestion, transport, and processing of dietary lipids.

Selection of HSC questions from work booklet

14 The table shows the base triplets in mRNA for amino acids.

From the table, the amino acid Serine (Ser) can be coded for by the base triplet UCG.

Base triplets found in messenger RNA

First base		Second base				Third base
		U	**C**	**A**	**G**	
	U	Phe	Ser	Tyr	Cys	U
		Phe	Ser	Tyr	Cys	C
		Phe	Ser	Stop	Stop	A
		Phe	Ser	Stop	Trp	G
	C	Leu	Pro	His	Arg	U
		Leu	Pro	His	Arg	C
		Leu	Pro	Gln	Arg	A
		Leu	Pro	Gln	Arg	G
	A	Ile	Thr	Asn	Ser	U
		Ile	Thr	Asn	Ser	C
		Ile	Thr	Lys	Arg	A
		Met	Thr	Lys	Arg	G
	G	Val	Ala	Asp	Gly	U
		Val	Ala	Asp	Gly	C
		Val	Ala	Glu	Gly	A
		Val	Ala	Glu	Gly	G

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Which base triplet could code for the amino acid Tyrosine (Tyr)?

(A) CCU

(B) CAU

(C) UAA

(D) UAC

- Show similarities and differences

- Use diagram to support your answer OR you may need to evaluate a model and identify similarities and differences

- Important to relate directly to features of model given or drawn

Mod 5 – Question 15 (3 marks)

There are some significant differences in the form that DNA has in prokaryotic and eukaryotic cells.

In the space provided draw a labelled diagram demonstrating the difference in the form of DNA between prokaryotic and eukaryotic cells.

3
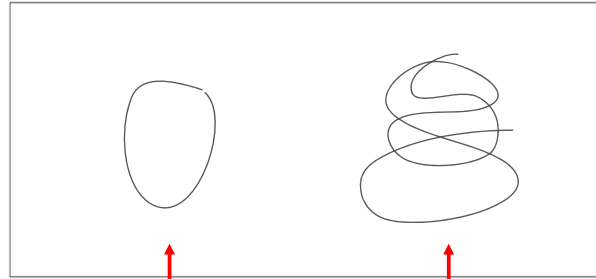
DNA in prokaryotes is circular

DNA in eukaryotes is tightly coiled (wound around a histone proteins)

Inquiry question 4
How can genetic similarities and differences within and between species be compared?

Outcome 12.4a.

conduct <u>practical investigations</u> to **predict** variations in the <u>genotype</u> of offspring by **modelling** meiosis, including the <u>crossing over of homologous chromosomes</u>, <u>fertilisation</u> and <u>mutations</u>

- determine aim, hypothesis and method for an investigation

- create a model (physical and mathematical -punnett squares will need to be used) to show how each process occurs

- model must include genotypes of parents (e.g. TT x tt) - good to incorporate linked genes here to show greater understanding of the effect crossing over

- annotate the models to give clear steps

- show the outcomes (results) in genotypes of offspring

- discuss the importance of each process in ensuring continuity of species. Address crossing over, homologous chromosomes, fertilisation and mutation make sure you refer to VARIATION.

Sister chromatids Crossing over Independent assortment

| INTERPHASE | MEIOSIS I | MEIOSIS II | PRODUCTS |

Before: After:

Random segregation

PI PII

MI MII

Fertilisation & mutations

One cell: Diploid (2n)

AI AII

Four cell: Haploid (n)

Homologous chromosomes

2n = 4

n = 2

TI TII
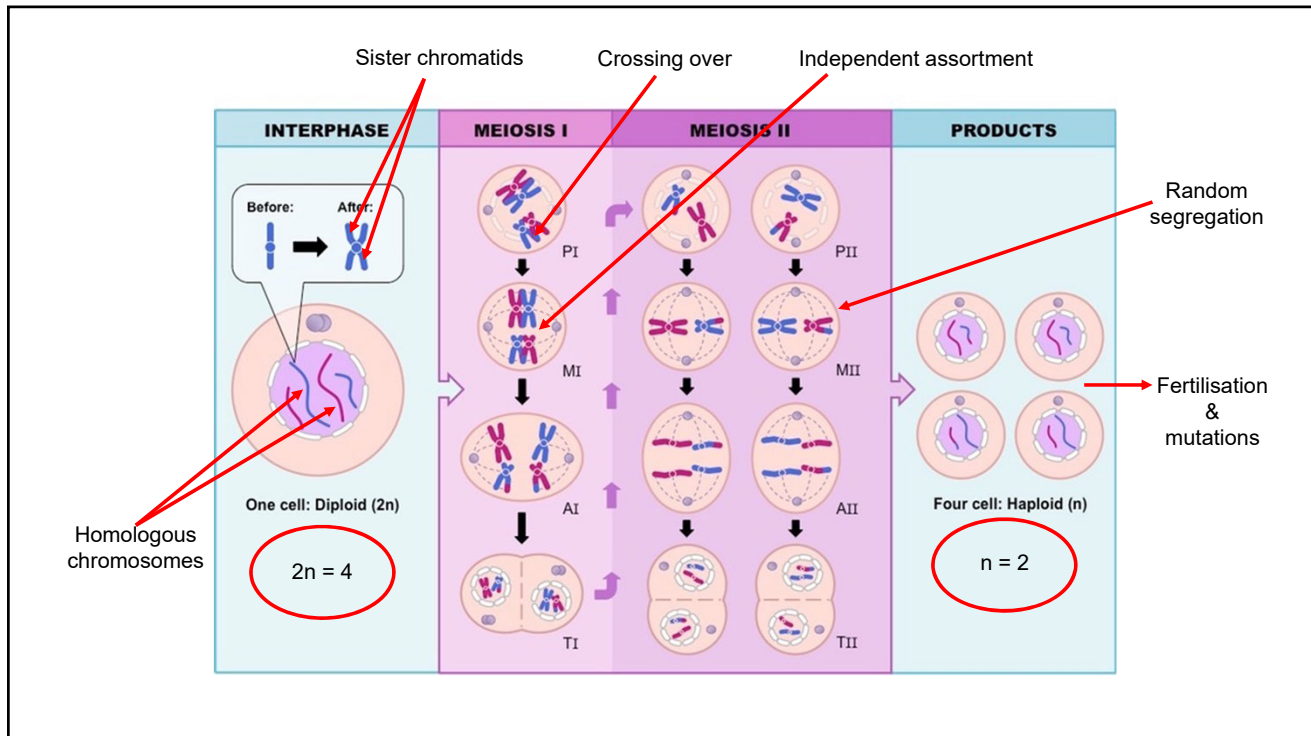
Outcome 12.4b.

model the formation of new combinations of genotypes produced during meiosis, **including but not limited to:**
- **interpreting** examples of autosomal, sex-linkage, co-dominance, incomplete dominance and multiple alleles
- **constructing and interpreting** information and data from pedigrees **and** Punnett squares

- distinguish between genes, alleles, dominant and recessive alleles
- distinguish between different patterns of inheritance (identify unique characteristics of each types of inheritance pattern)
- construct/draw punnett squares to show predict genotypes of offspring or parents

constructing and interpreting information and data from pedigrees and Punnett squares
- define pedigree
- outline the importance of using pedigrees to show new combinations of trait inherited over generations within a family tree (human and animal pedigrees)
- construct pedigrees with correct
  - key to identify males and females
  - key to identify affected vs non affected individuals
  - correct lines to show marriage/partnerships (line across) and offspring (branching)
  - give reasoning/justification for identified pattern of inheritance (autosomal recessive because unaffected parents produce affected offspring, no sex bias)
- use punnett squares for justification

Outcome 12.4c.

collect, **record** and **present** data to represent frequencies of characteristics in a population, in order to **identify** trends, patterns, relationships and limitations in data, **for example:**
- examining frequency data
- analysing single nucleotide polymorphism (SNP)

- research or extract data from secondary source

- tabulate and graph data

- identify trends in data (what is being shown/what is the correlation between dependent and independent variables)

- describe similarities or differences (relationships) in different sets of data and give reasons for these differences (relate to selective pressures and evolution)

- identify limitations in data and give suggestions of additional data needed to validate information and conclusions
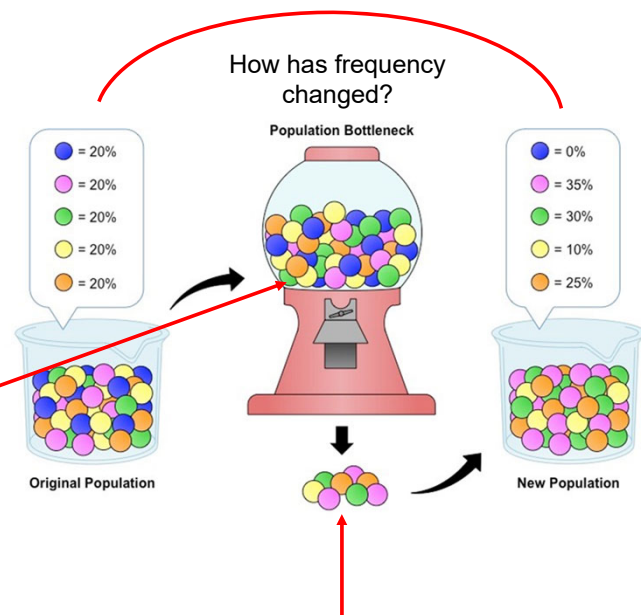
Limitations
- Were the balls evenly spread out over the gap?
- New population arose due to chance or genetic advantage? Were some balls heavier than others and therefore fell through
- Only 2 generations shown -cannot see long term effects

How has frequency changed?

Population Bottleneck

= 20%
= 20%
= 20%
= 20%
= 20%

= 0%
= 35%
= 30%
= 10%
= 25%

Original Population

New Population

Reasons for changes in population - relate directly to the selective pressure → link to genetic drift

---

Allele frequency

Allele frequency = the fraction of a particular allele within a defined population.

Eg. A population of 100 diploid individuals each carries two copies of each gene (a total of 200 gene copies)

If 40 individuals are heterozygous for allele A, and 10 individuals are homozygous for allele A, the total number of A alleles in the population would be 40 + 20, for a total of 60.

The allele frequency of A is therefore 60/200 = 0.3

The allele frequency of a is therefore 140/200 = 0.7

Single nucleotide polymorphism (SNP)

Single nucleotide polymorphism (SNP - pronounced "snips"), is a point mutation (single base; G, C, A or T) in a segment of DNA that occurs in more than 1% of a population.

An example of an SNP is the substitution of a C for a G in the nucleotide sequence AAC**G**AT, thereby producing the sequence AAC**C**AT.
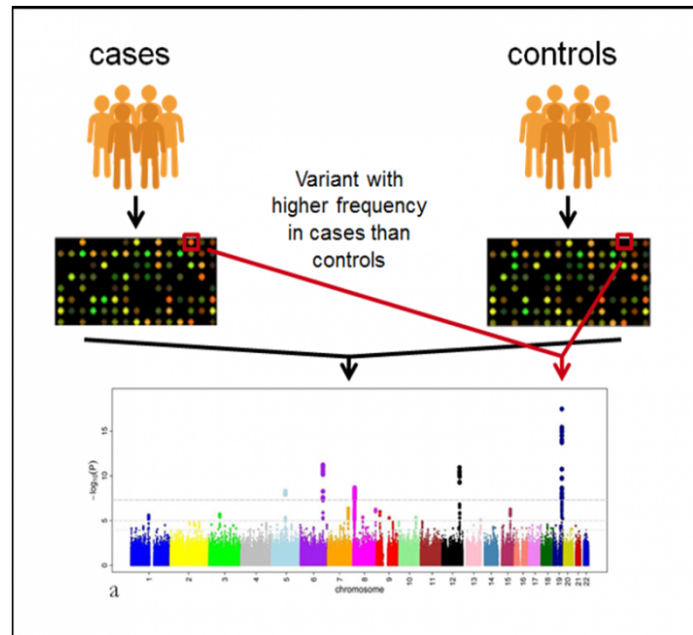
Selection of HSC questions from work booklet

15 In a particular sex-linked disease, progressive weakening of the muscles and loss of coordination lead to death before the age of five.
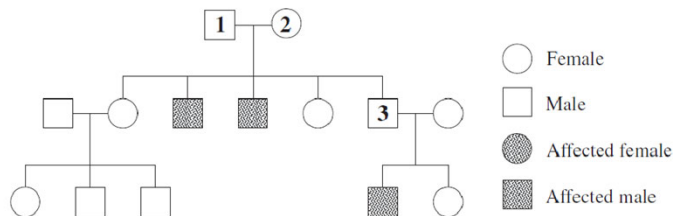
Using this pedigree, what is the genotype of the individuals numbered **1**, **2** and **3**?

	Individual 1	Individual 2	Individual 3
(A)	Normal	Normal	Normal
(B)	Carrier	Normal	Carrier
(C)	Normal	Carrier	Normal
(D)	Normal	Carrier	Carrier

11 The family tree shows the inheritance of a genetic characteristic.
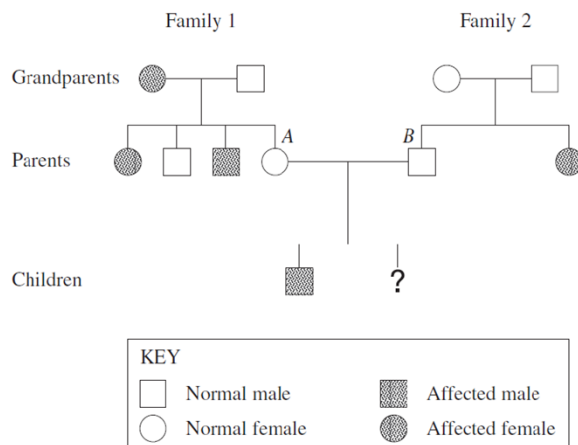
What is the probability that a daughter of parents *A* and *B* would be affected?

(A) 0%

(B) 25%

(C) 50%

(D) 100%

15   Goltz Syndrome is a condition in humans that adversely affects the skin. It is inherited as a dominant gene carried on the X chromosome.

A man with Goltz Syndrome and a woman who does NOT have the trait have two children, a boy and a girl.

Which of the following is correct about the inheritance of Goltz Syndrome in these children?

(A)   Both children have the syndrome.

(B)   The girl has the syndrome and the boy does not.

(C)   The girl has the syndrome and the boy is a carrier.

(D)   The girl has a 50% chance of having the syndrome and the boy has a 0% chance.

Question 30 (8 marks)

Explain how our knowledge of chromosome structure has led to reproductive technologies that have the potential to alter the path of evolution.

8

Knowledge of chromosome structure requires details of:
- DNA, genes, alleles, dominant, recessive, meiosis and variation

Explicit detail of key steps of evolution

Plural = must address more than one technology
- Cloning
- GMO
- Artificial pollination and insemination

Explain = cause and effect

Eg. Cloning reduced genetic variation. As a result ………

Slide 1

Question 28 (3 marks)

A pedigree chart of an inherited characteristic is shown.   3

I

II

III

- ■ Affected male
- ● Affected female
- □ Unaffected male
- ○ Unaffected female
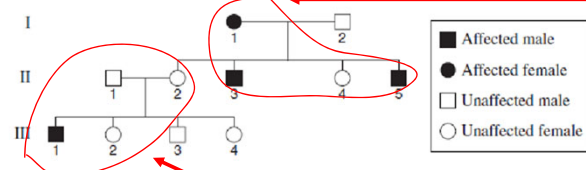
Subsequent genetic analysis showed I-2 does not have the recessive allele.

Explain the inheritance of this characteristic.

....
....
....
....
....
....
....
....

Important to be able to identify patterns
- Shows that it is sex linked- need to justify
- If I-2 was autosomal AA, then offspring (II3 and 5 could not express the trait)
- Sex bias (male) and affected mother always passes X chromosome to sons

Important to be able to identify patterns
- Unaffected parents with affected offspring = recessive
- Must justify
- Must identify that both parents are heterozygous for trait and offspring that is affected is homozygous for recessive allele

Slide 2

Inquiry question 5
Can population genetic patterns be predicted with any accuracy?

Outcome 12.5a.

investigate the <u>use of technologies to determine inheritance patterns in a population</u> using, **for example:**
• DNA sequencing and profiling

DNA sequencing and DNA profiling

DNA sequencing is the process of determining the precise order of nucleotides within a DNA molecule

DNA profiling involves the testing of highly variable regions of an individual's DNA that contain short repeating sequences called STRs (short tandem repeats)

The exact number of STRs varies from person to person. Because we inherit our DNA from our parents, DNA profiles can be used to confirm how closely related people are and therefore trace inheritance patterns
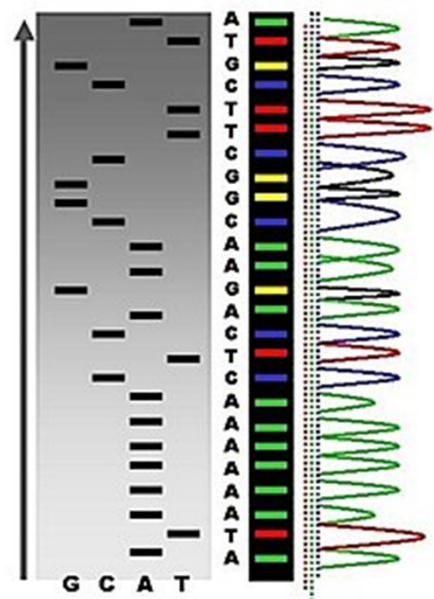
- identify technologies used to determine inheritance patterns (DNA sequencing and profiling
- describe the steps involved in the use of each technology
- describe the uses of each technology in determining inheritance patterns in a population

Electrophoresis
DNA fragments move based on size (number of base pairs) AND charge

Negatively charged end (cathode)
DNA also negatively charged

Smallest fragments travel farthest

Positively charged

Recommended research

GeneEd:
https://geneed.nlm.nih.gov/index.php

DNAi:
http://www.dnai.org/index.htm

How DNA sequencing works:
https://www.extremetech.com/extreme/214647-how-does-dna-sequencing-work
http://www.bloodjournal.org/content/122/19/3268
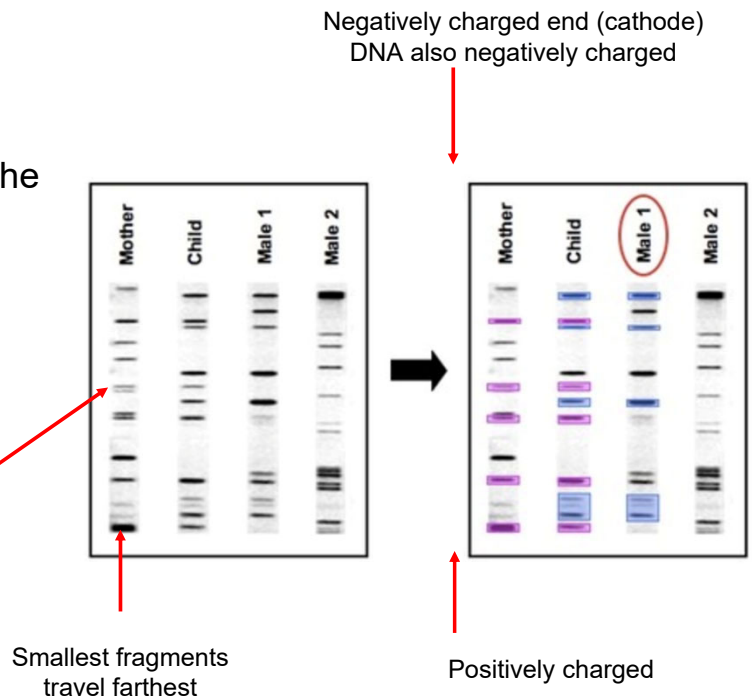
Massively Parallel sequencing:
https://geneed.nlm.nih.gov/index.php

PCR:
https://www.youtube.com/watch?v=iQsu3Kz9NYo

The Sanger method of DNA sequencing:
https://www.youtube.com/watch?v=FvHRio1yyhQ
https://www.youtube.com/watch?v=3M0PyxFPwkQ

DNA profiling- Who am I?:
http://www.sciencemuseum.org.uk/whoami/findoutmore/yourgenes/whydoscientistsstudygenes/whatisdnaprofiling

Outcome 12.5b.

investigate the use of <u>data analysis from a large-scale collaborative project</u> to **identify** <u>trends, patterns</u> **and** <u>relationships</u>, **for example:**
- the use of <u>population genetics</u> data in conservation management
- population genetics studies used to determine the inheritance of a disease or disorder
- population genetics relating to human evolution

- Define population genetics
- research or extract data from secondary source
- tabulate and graph data
- identify trends in data (what is being shown/what is the correlation between dependent and independent variables)
- describe similarities or differences (relationships) in different sets of data and give reasons for these differences (relate to selective pressures and evolution)
- Explains how changes in allele frequencies arise and how these changes lead to microevolution (changes over short periods of time)
- Use of quantitative data to to determine frequencies of alleles in populations and how these change over generations with relation to a specific disease or disorder

Human Genome Project (HGP)

The HGP was an **international effort** to decode the entire sequence of the human genome. Completed in 2003. Attention turned to deciphering the code

Used PCR and the Sanger method of DNA sequencing. Complete and accurate sequence of 3 billion DNA base pairs and an estimated 20000 to 25000 genes.

• Finding variations in the DNA sequence responsible for diseases

• Develop genome-based strategies for detection, diagnosis, and treatment of disease

• Determine how DNA and environment interact to influence protein expression

---

With the HGP completed in 2003 attention turned to deciphering the code.

In 2005, an International collaboration developed and published a haplotype map (HapMap) of the human genome.

Used to find genetic variations responsible for diseases and predict the response of different gene combinations to medications and environmental factors.

Multiple SNPs that are inherited together are referred to as tag-SNPs and form a haplotype. These tag-SNPs can be used in GWAS to identify genetic variations that are associated with diseases and disorders by comparing groups of individuals with and without the condition.

Avoids the need to perform full genome sequencing.

Recommended research

Human Genome Project:
https://www.youtube.com/watch?v=MvuYATh7Y74
https://www.youtube.com/watch?v=WX8V1SWQbFw

National Human Genome Research Institute:
https://www.genome.gov/10001772/all-about-the--human-genome-project-hgp/

What are the next steps in genomic research?
https://ghr.nlm.nih.gov/primer/genomicresearch/nextsteps

What does it mean to be human?:
http://humanorigins.si.edu/evidence/genetics

Genome-wide association study (GWAS)

Multiple GWAS success stories have involved international collaborations utilising results of the HGP, tag-SNPs and the HapMap to share large-scale genotyping data.

Examples
Prostate cancer (PrCa) is the most common cancer in men. 170 common genetic variants have been linked to PrCa.

Parkinson's disease is a degenerative neurological condition that affects the control of body movements. Recent GWAS discovered 35 genes with links to the disease.

These gene associations will now be used to in screening, tailored treatments and possible cures.

Conservation Genetics: Case Study- Cheetah

CITES is an **international agreement** between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

Conservation Genetics: Case Study- Cheetah

There are approximately 7000 cheetahs left in the wild. The species is restricted to less than 10% of its historic range and survives in only 33 populations, most consisting of <100 individuals.
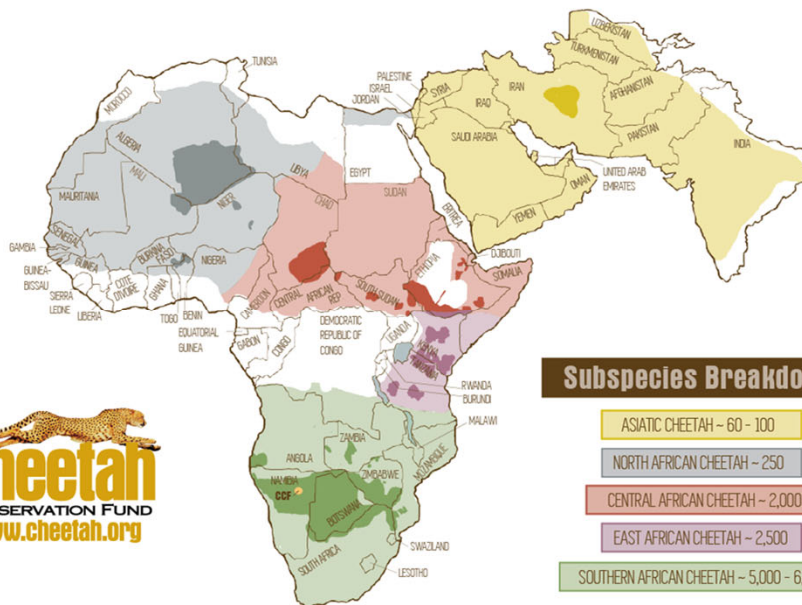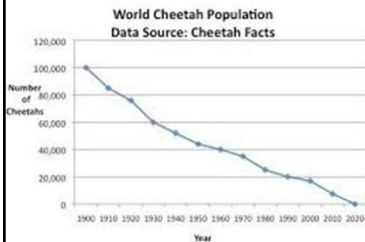
Conservation Genetics: Case Study- Cheetah

Original cheetah population contains 25 different alleles of a particular gene.

Cheetah population is drastically reduced.

Repopulation occurs. Only three different alleles remain.
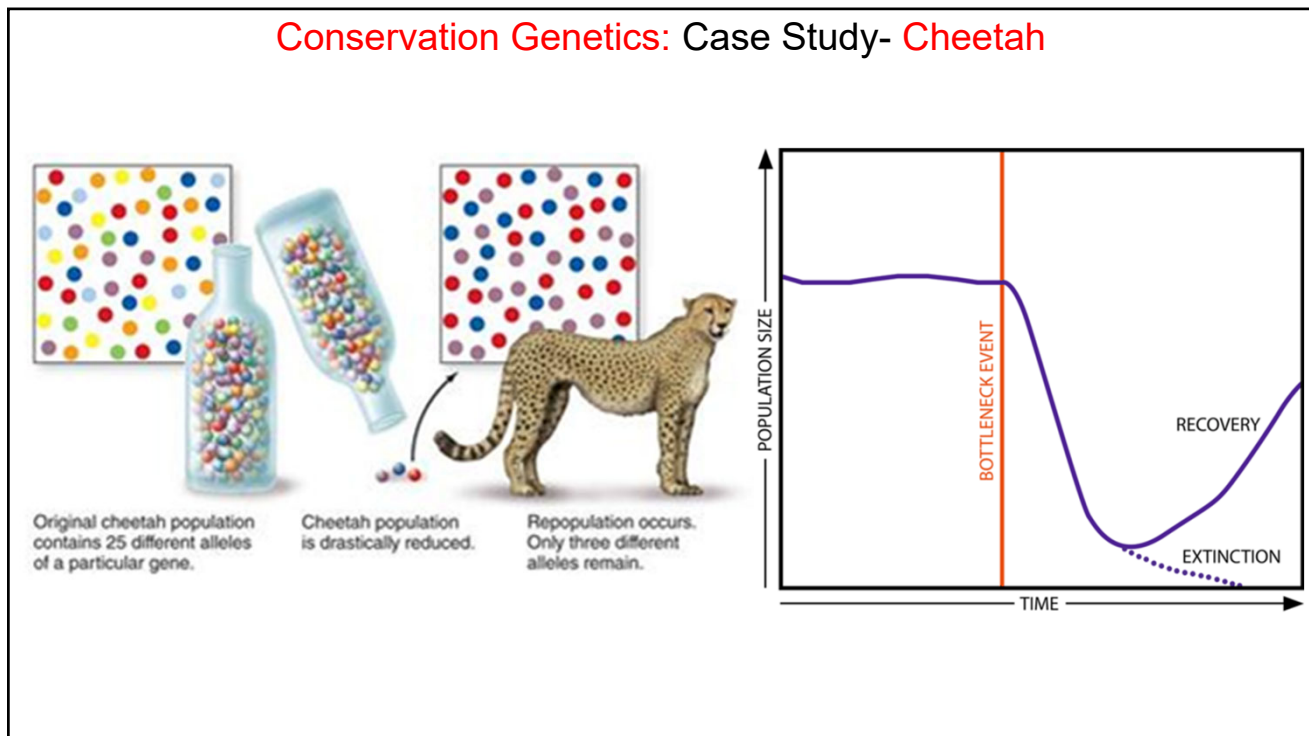
Conservation Genetics: Case Study- Cheetah

Pre-genetic screening:
Captive breeding programs had high mortality rates with only 15% success rate. On top of this there was a 30-40% cub mortality.

Male cheetah's had a sperm count 10x lower than other large cat species. In addition, up to 75% sperm were malformed.

The lack of reproductive success in initial zoo breeding programs was due to inbreeding which reduces genetic variation further.

Genetic screening:
Commenced in 1990s. PCR analysis of multiple STR's across all sub-populations of cheetah. Confirmed 90–99% less overall genetic diversity than other large cats and mammals; one of the lowest ever recorded.

Conservation Genetics: Case Study- **Cheetah**

Population genetics has allowed scientists to measure the genetic variation across all wild sub-populations and all captive breeding populations of cheetah.

Multiple individuals from each group have been analysed across multiple genes. Led to **world wide breeding initiative** to both maintain, and improve gene pool.

Given the shared ancestry, current attempts to repopulate the Asian population with African individuals.

Conservation Genetics: Case Study- **Cheetah**

World Association of Zoos and Aquariums (WAZA) in collaboration with the Cheetah Conservation Fund (CCF) maintains an International Cheetah Studbook

Worth a watch: Cheetah Conservation At The Genetic Level
https://www.youtube.com/watch?v=HdtxnzwzgaQ

Selection of HSC questions from work booklet

Mod 5 – Question 18 (6 marks)

A student plans to investigate whether the development of insulin has affected the prevalence of Type 1 diabetes in the human population and subsequently influenced human evolution. She has access to data on Australians with diabetes extending back to 1973.

(a) Propose a suitable hypothesis for this investigation.　　　　2

Must be an educated prediction **related directly to stimulus** - prevalence of type 1 diabetes in relation to use of insulin with explanation

(b) Identify TWO variables that need to be controlled for this investigation and explain their importance.　　　　4

Validity.

Be able to distinguish between validity, reliability and accuracy

Question 18 (continued)

Sample answer:

One variable the student will need to control for is the increase in the Australian population since 1973. Just counting the increase in numbers without taking into account population increases will give a biased result as even without an increase in prevalence it would be expected that the total numbers will increase as the population increases. The prevalence will need to be measured using a rate such as number of people with Type 1 diabetes per 100 000 people.

Another variable that may affect results, and therefore reduce the validity of the data, is the length of time the subject has used insulin or since diagnosis. This data may also be useful if determining whether the prevalence of Type 1 diabetes is caused by more people being diagnosed or more people surviving for a longer time.

Question 26 (5 marks)

The map shows the percentage of adult indigenous populations able to digest lactose.   **5**
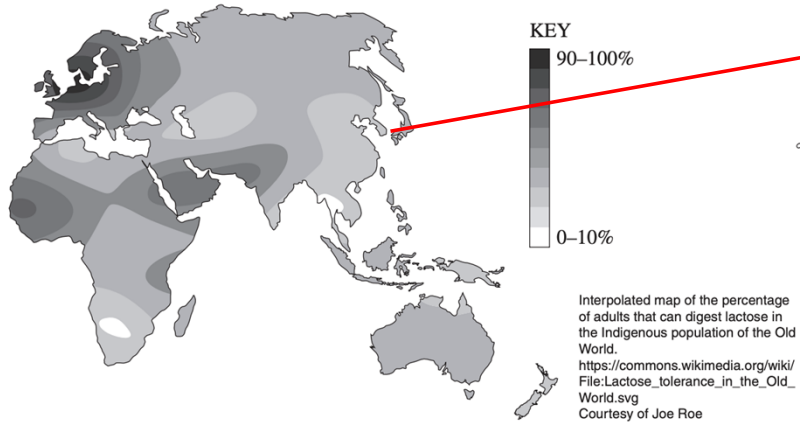
KEY
90–100%

0–10%

Interpolated map of the percentage of adults that can digest lactose in the Indigenous population of the Old World.
https://commons.wikimedia.org/wiki/File:Lactose_tolerance_in_the_Old_World.svg
Courtesy of Joe Roe

The ability to digest lactose is due to the presence of an enzyme (lactase) which can metabolise the sugar (lactose) present in milk. The gene responsible for producing lactase is usually permanently switched off at some time between the ages of 2 and 5 years. However, some people remain able to digest lactose throughout their lives.

With reference to evolution and DNA, provide possible reasons for the distribution shown in the map.

*Must be an educated prediction **related directly to stimulus** - prevalence of type 1 diabetes in relation to use of insulin with explanation*

Question 26

Criteria	Marks
• Identifies variation in lactose tolerance with reference to stimulus • Provides reasons for the variation with detailed reference to evolution and DNA	5
• Identifies variation in lactose tolerance with reference to stimulus • Provides reasons for the variation with some reference to evolution and DNA	4
• Identifies variation in lactose tolerance with some reference to stimulus • Provides reason(s) for distribution of lactose tolerance with some reference to evolution OR DNA	3
• Identifies variation in lactose tolerance with some reference to stimulus • Provides a suitable reason for the distribution of lactose tolerance	2
• Provides some relevant information	1

Note the explicit between the marking criteria and question details

ALWAYS analyse question before committing pen to paper

Sample answer:

The map shows that ability to digest lactose varies in adult populations around the world. For example it is much lower in Australia than Northern Europe. This variation is likely to be due to natural selection where the presence of milk in the diet is the selective pressure. A mutation to a gene is likely to cause the continued production of lactase past the age of five years. Adults who possess the mutation are likely to have an increased chance of survival as they have increased nutrition in their diets. They then reproduce and pass the mutation on to their offspring, making it more common in the population. Populations that have remained largely lactose intolerant are less likely to have had milk available and thus a mutation of the lactase gene would not offer any advantage and would not become more common in the population.
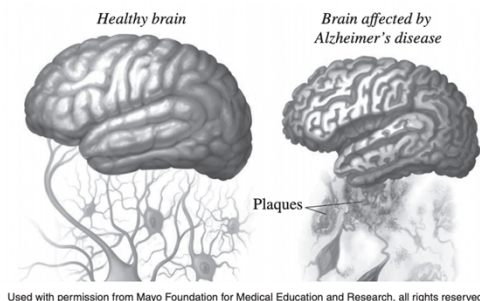
Higher mark questions will typically be across multiple modules and include skills.

Eg. 2019 HSC paper. 20 marks total. Included module 5-8 and skills.

Question 33 (20 marks)

Alzheimer's disease causes destruction of brain tissue, dementia and eventually death.

The diagram shows the effect of Alzheimer's disease on the brain. →→ Module 7

Healthy brain

Brain affected by Alzheimer's disease

Plaques

Used with permission from Mayo Foundation for Medical Education and Research, all rights reserved

(a) Amyloid beta protein is produced in the human brain throughout life. In people with Alzheimer's disease, it accumulates in excessive amounts. **3**

Outline the main steps that brain cells use to make proteins such as amyloid beta. →→ Module 5

Question 33 (continued)

(b) The gene with the greatest known effect on the risk of developing late-onset Alzheimer's disease is called APOE. It is found on chromosome 19.

The APOE gene has multiple alleles, including e2, e3 and e4.

(i) What are multiple alleles? →→ Module 6 **2**

....
....
....
....

(ii) The table shows the risk of developing Alzheimer's disease for various APOE genotypes compared to average risk in the population. **4**

APOE genotype	e2/e2	e2/e3	e2/e4	e3/e3	e3/e4	e4/e4
Risk of developing Alzheimer's disease (compared to average)	40% less likely	40% less likely	2.6 times more likely	Average	3.2 times more likely	14.9 times more likely

Risk of susceptibility, based on alleles. © Alzheimer.org

skills

Analyse the data to assess the risk of developing Alzheimer's disease associated with the e2, e3 and e4 alleles.

For your later perusal. Analyse the question first and determine where you think the marks will be allocated.

Question 33 (a)

Criteria	Marks
• Outlines processes of transcription AND translation	3
• Provides features of transcription AND/OR translation	2
• Provides some relevant information	1

Sample answer:

The DNA is unzipped and a complementary mRNA strand is transcribed. The mRNA moves to the ribosomes where translation occurs. Each codon is matched to a tRNA molecule with a complementary anticodon and carries a specific amino acid. The amino acids are joined together to form a polypeptide/protein.

Question 33 (b) (i)

Criteria	Marks
• Provides a suitable definition	2
• Provides some relevant information	1

Sample answer:

Alleles are different versions of a gene. 'Multiple alleles' refers to three or more versions of a gene existing in a population.

Question 33 (b) (ii)

Criteria	Marks
• Analyses the data to provide relevant conclusions about the risk associated with the alleles and combinations of alleles	4
• Analyses the data to provide suitable conclusions about the risk associated with the alleles	3
• Outlines risks associated with alleles	2
• Provides some relevant information	1

Sample answer:

The presence of e2 reduces the risk of AD. When it is present in the homozygous genotype or heterozygous with e3 there is a 40% reduction in risk of AD. The e2 allele appears to mask the effect of the e3 allele (e2 is dominant over e3). When e2 is combined with e4 AD is 2.6 times more likely, suggesting that e2 cannot fully mask e4. If two e4 alleles are present the risk of AD is greatly increased and is 14.9 times more likely. This suggests that e2 reduces the risk of AD and that e4 significantly increases the risk of AD.

When the individual is homozygous for the e3 allele there is an average risk of AD. However when e3 and e4 are present together the presence of e3 appears to reduce the increased risk that is the result of the e4 allele (e3/e4 makes AD 3.2 times more likely).

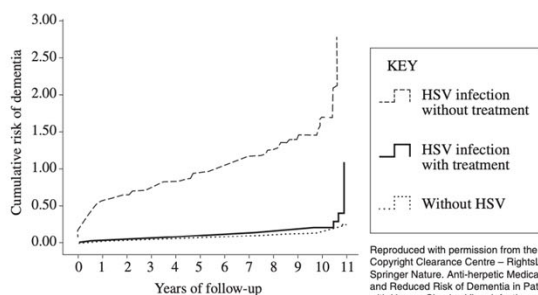Higher mark questions will typically be across multiple modules and include skills.

Eg. 2019 HSC paper. 20 marks total. Included module 5-8 and skills.

Module 7 and 8

Question 33 (continued)

(c) A large epidemiological study was conducted. It used historical data to investigate the association between *Herpes simplex* virus (HSV) infection and dementia. Dementia is caused by a variety of brain illnesses. Alzheimer's disease is the most common cause of dementia. **3**

The study used the records of 8362 patients with HSV infection and 25086 randomly selected sex- and age-matched control patients without HSV infection. Some of the patients with HSV had been treated with antiviral medication.

The graph below shows some results of the study.

KEY

⎕ HSV infection without treatment

⎕ HSV infection with treatment

⎕ Without HSV

Reproduced with permission from the Copyright Clearance Centre – RightsLink: Springer Nature. Anti-herpetic Medications and Reduced Risk of Dementia in Patients with Herpes Simplex Virus Infections — a Nationwide, Population-Based Cohort Study in Taiwan. Fig 1 (Neurotherapeutics) Nian-Sheng Tzeng, Chi-Hsiang Chung, Fu-Huang Lin et al. © 2018

Describe the trends shown in the data.

Skills

Question 33 (continued)

(d) Diseases are classified as infectious or non-infectious. **8**

Evaluate whether Alzheimer's disease should be classified as an infectious disease or a non-infectious disease. In your answer, include reference to the information and data provided throughout Question 33.

For your later perusal. Analyse the question first and determine where you think the marks will be allocated.

Question 33 (c)

Criteria	Marks
• Describes trends in the data	3
• Outlines trends in the data	2
• Provides some relevant information	1

Question 33 (d)

Criteria	Marks
• Demonstrates an extensive knowledge of infectious and non-infectious disease, including criteria for classification of disease • Supports the classification of AD with detailed and appropriate reference to information and data provided • Justifies a suitable judgement • Communicates logically and succinctly with precise biological terms	8
• Demonstrates a thorough knowledge of infectious and non-infectious disease, including criteria for classification of disease • Supports the classification of AD with appropriate reference to information and data provided • Justifies a suitable judgement • Communicates logically using biological terms	7
• Demonstrates a sound knowledge of infectious and non-infectious disease, including reference to criteria for classification of disease • Supports the classification of AD with some reference to information and data provided • Provides a suitable judgement • Communicates effectively using biological terms	5–6
• Demonstrates some knowledge of the infectious and/or non-infectious disease • Relates data to classification of AD	3–4
• Provides information about infectious or non-infectious disease and AD data OR • Relates data to classification of AD OR • Provides information about infectious and non-infectious disease	2
• Provides some relevant information	1

Sample answer:

Patients with untreated HSV infection have an increased risk of developing dementia each year compared to patients who are not infected or are treated. Both treated and untreated HSV infection groups show a sharp increase in the risk of dementia after 10 years, but the untreated HSV group increases to more than double the risk of the treated HSV group. The group that did not have HSV infection only has a very small increase in risk after 10 years.

Sample answer:

Infectious diseases are caused by pathogens that can be passed from one person to another. A pathogen is established as a cause of disease using a rigorous set of criteria known as Koch's postulates.

The data from the study provides evidence for an association between untreated viral (HSV) infection and the increased risk of development of dementia. The data also shows that treating HSV patients with antiviral medication results in a much lower risk of dementia over the following years. This provides some evidence that the disease may be infectious – a result of infection with the virus *Herpes simplex*. A strength of the study was the large number of patients, the length of time of the study and the way the control group was matched to the HSV group. These factors add validity to the findings.

However, this does not prove that HSV actually causes dementia, as Koch's postulates would need to be fulfilled. Additionally the historical study obtained results about dementia, and not all of the dementia cases would have been Alzheimer's disease (although AD is the commonest cause of dementia). This reduces the validity of the findings in terms of establishing HSV as a cause of AD.
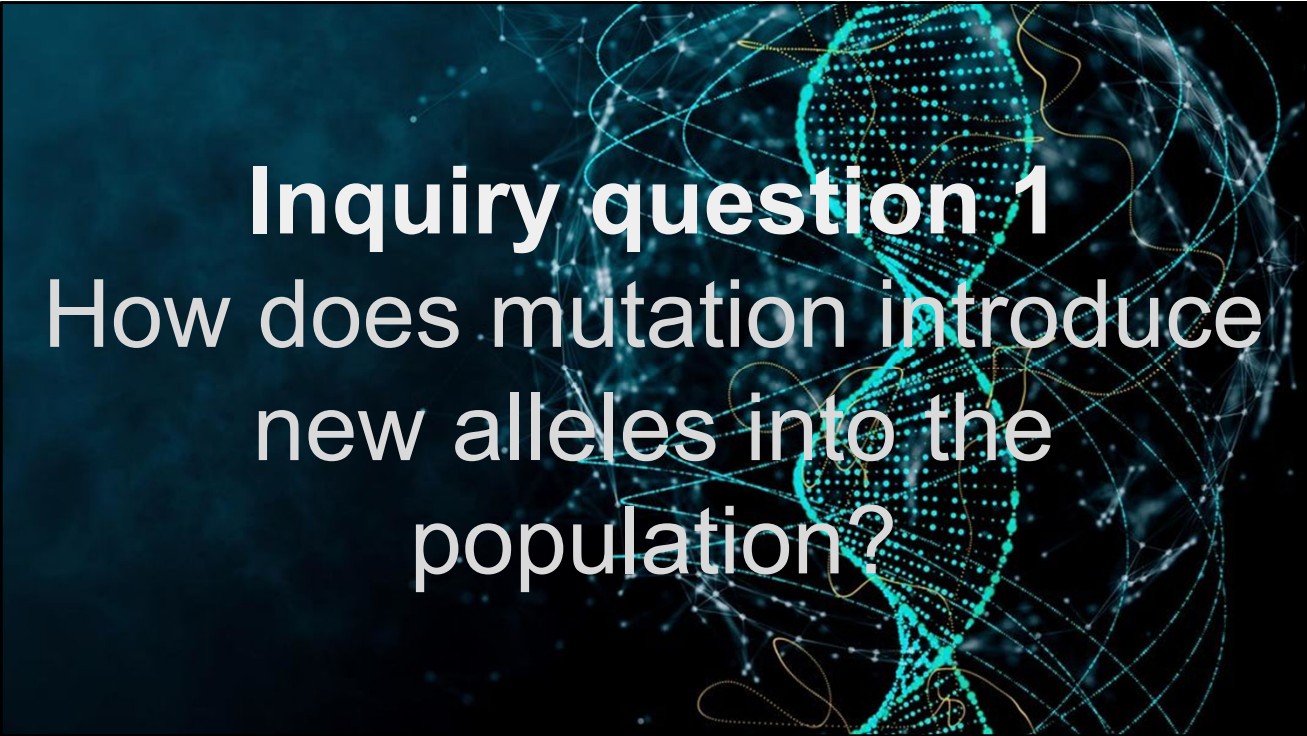
Non-infectious diseases do not spread from person to person and are not caused by pathogens. They are caused by other factors such as environmental factors or inherited genes.

AD is the result of the build up of amyloid protein. Protein synthesis is regulated by genes, suggesting the disease is non-infectious. The data about the APOE gene indicates that the presence of certain alleles, such as APOE-e4, result in a large increase in the risk of developing AD. It also appears that the presence of APOE-e2 allele reduces the risk of AD. This provides evidence for an inherited genetic basis for developing the disease, meaning that it could be classified as non-infectious. However, the development of AD may also be influenced by other genes and factors such as pathogens.

From the information provided it is not possible to classify Alzheimer's disease as infectious or non-infectious as there appears to be evidence that the risk of developing it is influenced by both a viral pathogen and genes.

Module 6
GENETIC CHANGE

Inquiry question 1
How does mutation introduce new alleles into the population?

A.L.A.R.M

In short, we **learn** in the following order

Identify (name and define)
Describe (characteristics and features)
Explain (cause & effect = link)
Assess/**E**valuate

Structure your **response** using the same logic and stop at the verb of the question.

Outcome 13.1.

Explain how a range of mutagens operate, including but not limited to:
- electromagnetic radiation sources
- chemicals
- naturally occurring mutagens

Mutations and mutagens

A **mutation** is a permanent change that occurs in our DNA sequence, either due to mistakes when the DNA is copied or as the result of environmental factors.

A mutagen is an agent or substance that can bring about this permanent change. For example:
- Ionising electromagnetic radiation (e.g. UV, x-rays, gamma rays)
- Chemicals (e.g. asbestos, nicotine in tobacco)
- Naturally occurring mutagens (e.g. viruses, transposons)

Recommended research

How ionising radiation causes cancer
https://www.youtube.com/watch?v=PQjL4ZDuq2o
https://www.youtube.com/watch?v=-xJ4u9YtDDo
https://www.youtube.com/watch?v=uFkKanLgvr4

How smoking causes cancer
https://www.youtube.com/watch?v=YaIHrWl2_NA
https://www.youtube.com/watch?v=HD__r66sFjk

HPV & cervical cancer: https://www.youtube.com/watch?v=pYQdc6P7qq8

Hepatitis C & liver cancer: https://www.youtube.com/watch?v=IxCelFhuhQo

Jumping genes (transposable elements):
https://www.youtube.com/watch?v=7Dz3on0BwF0

Cancer Quest: https://www.cancerquest.org/cancer-biology/mutation

Effect of mutations

RADIATION DAMAGE TO DNA

H2-Bond Breakage — Double-Strand Break
Pyrimidine Dimer
Base Loss
DNA Cross-Linkage — Base Change
Cross-Linkage
Single-Strand Break
Protein Cross-Linkage
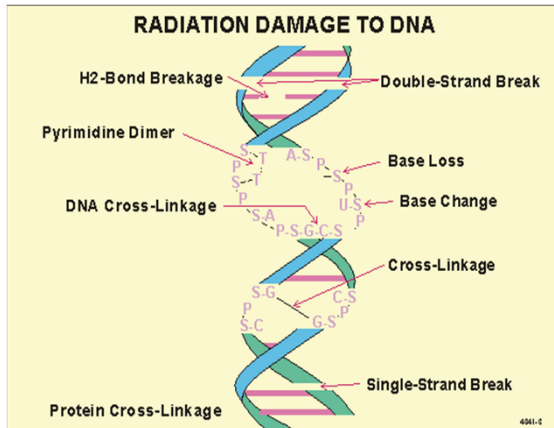
- HOW = EXPLAIN = CAUSE (DEFINE/DESCRIBE) AND EFFECT (WHAT IS THE EFFECT OF THE CAUSATION)
- CAUSE:
  - define mutation
  - define allele
  - identify and describe different types of mutations and how they occur
- EFFECT: how does each type of mutation introduce new alleles into the population
- MAKE LINK TO POLYPEPTIDE SYNTHESIS AND PRODUCTION OF PROTEINS

Outcome 13.1b.

Compare the causes, processes and effects of different types of mutation, including but not limited to:
- point mutation
- chromosomal mutation

COMPARE = show similarities and differences between the:
- o **causes** of point and chromosomal mutations
  - • chemical mutagens, radiation, mistakes during DNA replication and meiosis

- o the **processes** of point and chromosomal mutations and how these changes occur

- o the **effect** on gene sequences (point and chromosomal) and the chromosomal structure (chromosomal mutations)

- o give examples of specific types of point and chromosomal mutations

- • when comparing, it often helps to draw a table to show direct comparisons or clearly show similarities and differences

---

Point and chromosomal mutations

A **point mutation** occurs when a single nucleotide base is changed, inserted or deleted from a sequence of DNA. As a result the polypeptide synthesis could be affected.

A **chromosomal mutation** can involve either a change in the number of chromosomes or a rearrangement in the structure of a chromosome. For example, people with Down syndrome, or trisomy 21, have an additional chromosome 21. As a result they have 47 chromosomes instead of 46.

Worth a watch – Mutations in DNA:
https://www.youtube.com/watch?v=MOtRqBs0jxE
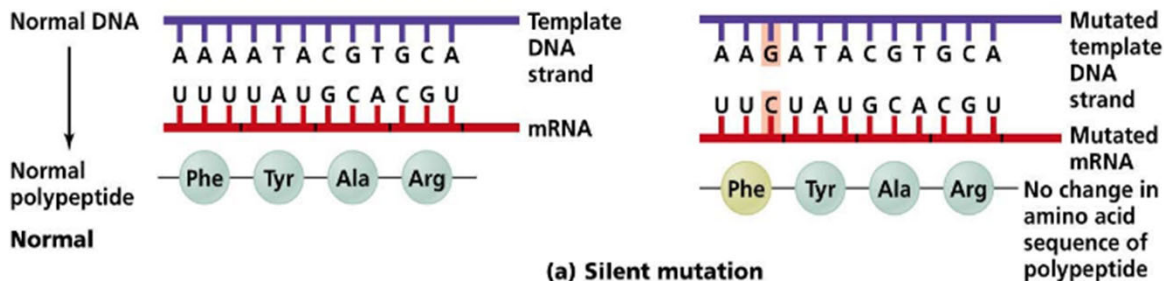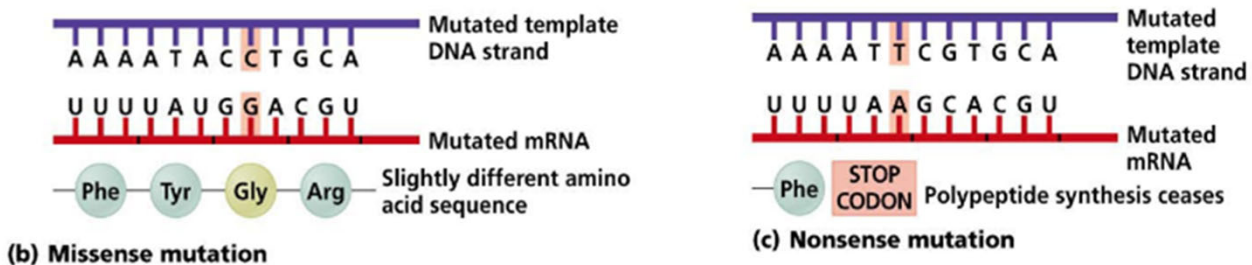
Types of point mutations

Types of point mutations

Types of point mutations

Frameshift mutations
Insertion

AAATATACGTGCA — Mutated template DNA strand

UUUAUAUGCACGU — Mutated mRNA

Phe — Ile — Cys — Thr — Major difference in amino acid sequence

(d) Frameshift insertion

Types of point mutations

AAAA ACGTGCA — Mutated template DNA strand

UUUU UGCACGU — Mutated mRNA

Phe — Leu — His — Val — Major difference in amino acid sequence

(e) Frameshift deletion
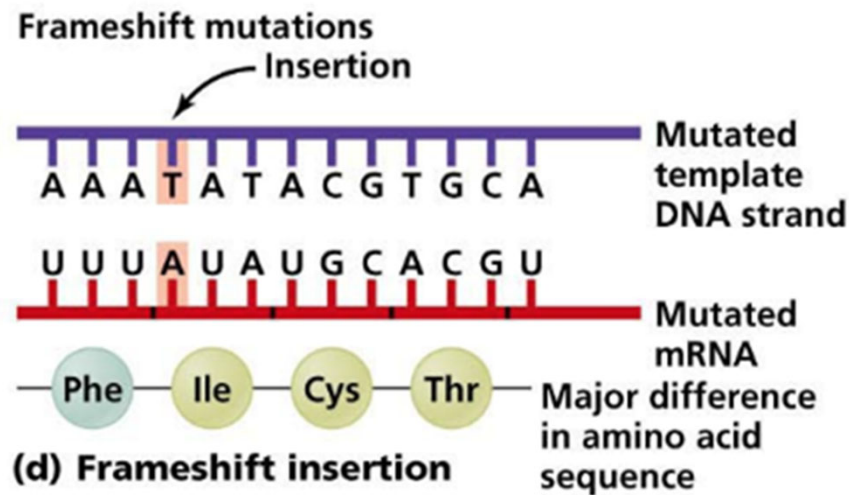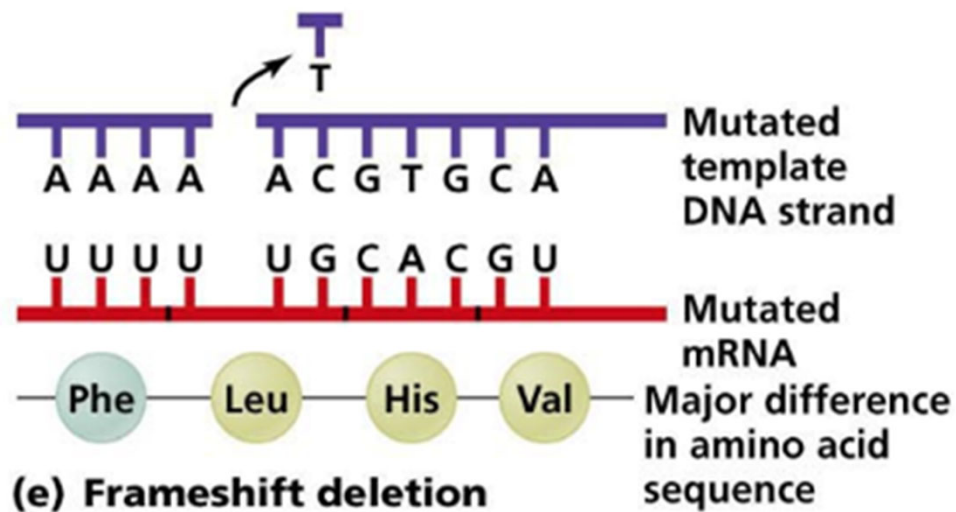
Types of chromosomal mutations
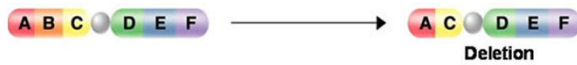
chromosomal segment lost
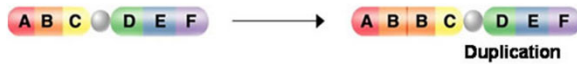
A segment from one chromosome is transferred to its homologous chromosome, giving it a duplicate of some genes
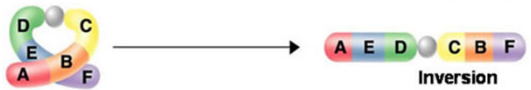
A segment of a chromosome arm is inverted
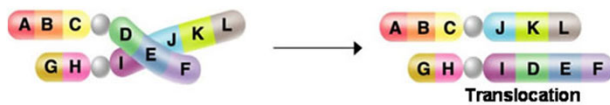
A segment from one chromosome is transferred to another

An extra chromosome is passed on from one parent

Worth a watch – Point & chromosomal mutations:
https://www.youtube.com/watch?v=GieZ3pk9YVo

Outcome 13.1c.
Distinguish between somatic mutations and germ-line mutations and their effect on an organism

Outcome 13.1d.
Assess the significance of 'coding' and 'non-coding' DNA segments in the process of mutation

- **Define** mutation
- **Distinguish** between somatic and germline mutations in terms of
    - Cells they affect
    - Effect on individuals
    - Effect on populations
- **Describe** (give features of) coding and non-coding DNA segments
- **Explain** effect of mutation in coding AND non-coding DNA segments
    - Relate to DNA replication and polypeptide synthesis
    - Effect on populations
    - Advantages/disadvantages of this type of mutation
    - Use examples to justify the effect
- **Assess** the significance (make a judgement)

Coding Regions

DNA

Exon Intron Exon Intron Exon Intron Exon Intron Exon

Non-coding Regions

Make proteins
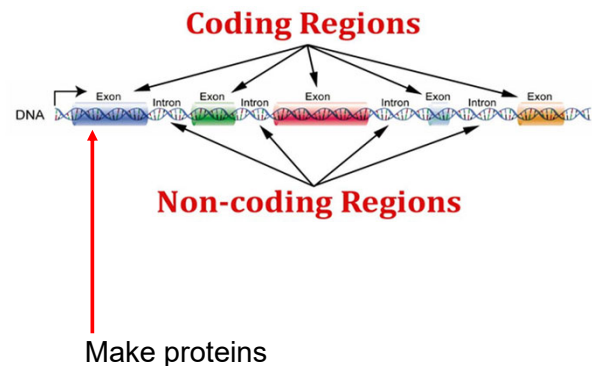
Examples of each to research

- Somatic point mutation (carcinogenesis- melanoma)

- Somatic chromosomal mutation (mosaic Down syndrome)

- Germ-line point mutation (cystic fibrosis)

- Germ-line chromosomal mutation (Down syndrome)

What the Encode project tells us about the human genome and 'junk DNA':
https://www.youtube.com/watch?v=UBQ5a7mCpMs

https://www.youtube.com/watch?v=XpNo-Z5k41w

Contrast the effect of a **frameshift mutation** with the effect of a **base substitution** mutation on the polypeptide produced within the non-coding sequence of this DNA strand

A T C A G T C G T A C G A T C G C A T A

Non-coding region
ATCAGTCG

Coding region
TACGATCGCATA
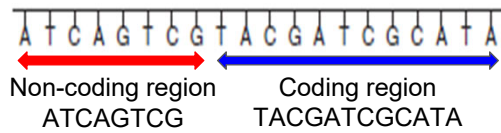
Insertion of a base in non-coding region leads to frameshift

Effect of a frameshift mutation
- Define frameshift mutation
- Show the effect of a frameshift mutation on the gene sequence of the non-coding region and coding region of DNA → amino acids → polypeptide

A T C A G T C G T A C G A T C G C A T A
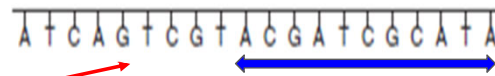
Push the sequence to the right- codons will change - FIRST CODON WILL NOW BE ACG instead of TAC → different amino acid produced → change polypeptide.
LITTLE TO CATASTOPHIC EFFECTS

Effect of a point mutation (base substitution)
- Define point mutation
- Show the effect of a point mutation on the gene sequence of the non-coding region
- Show its effect on the coding region → amino acid → polypeptide.
- LITTLE OR NO EFFECT

Outcome 13.1e.

Investigate the <u>causes</u> of genetic variation relating to the <u>processes</u> of fertilisation, meiosis <u>and</u> mutation

- *Define fertilisation, meiosis and mutation*
- ***Outline processes in meiosis that lead to variation***
  - *Random assortment and segregation of chromosomes*
  - *Crossing over*
  - *Ensure that you can clearly show the changes in the combinations of alleles in daughter cells/gametes→ **this is the link to genetic variation***
- ***Outline how fertilisation leads to variation***
  - *Show that paternal and maternal gametes have different combinations of alleles*
  - *Ensure that you can clearly show the changes in the combinations of alleles in daughter cells/gametes→ **this is the link to genetic variation***
  - *Give a specific example*
- ***Show how mutation leads to variation***
  - *Include examples of chromosomal (e.g. down syndrome) and point mutations (sickle cell anaemia)*
  - *Can produce a flowchart to show changes that occur in DNA sequence and resulting amino acids produced → changes to proteins expressed (variation)*

Shows different combinations of **alleles** and thus variation will arise in offspring
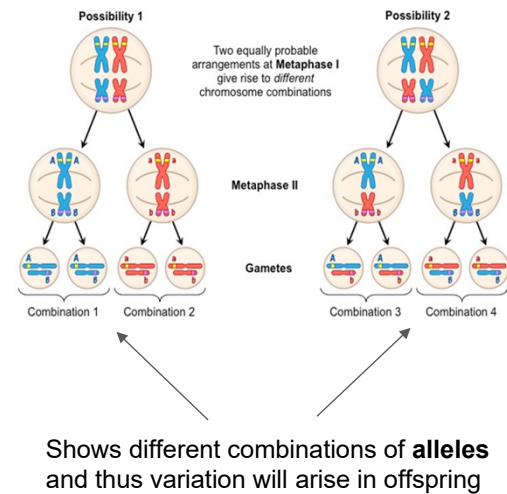
Outcome 13.1f.

Evaluate the effect of mutation, gene flow and genetic drift on the gene pool of populations

Gene pool, gene flow and genetic drift

Mutations introduce new alleles into a population.

Gene pool is the total genetic variation within a population.

Gene flow is defined as the movement of alleles **between** populations.

Genetic drift refers to the random change in allele frequencies within a gene pool over time. Due to **chance** event (e.g. bottleneck effect and founder effect).

Important to distinguish between genetic drift and natural selection

---

- **Define** mutation, gene flow, genetic drift and gene pool
- **Explain** how mutations change DNA sequences and polypeptides/proteins/characteristics
- Relate changes/mutations to natural selection - relate advantages and disadvantages of mutations to the gene pool of populations
- **Explain** how genetic drift affects the gene pool of populations
  - What are the advantages (**?**)/disadvantages

- **Explain** how gene flow affects the gene pool of populations
  - What are the advantages/disadvantages

- **Give a judgement** (needs to be **<u>explicit</u>**) relating to the effect of these changes in populations
  - Provide evidence for your judgement

Should always link to polypeptide synthesis

Mechanisms of Variation:

Mutation | Sexual Reproduction | Gene Flow

Mechanisms of Change:

Genetic Drift | Natural Selection
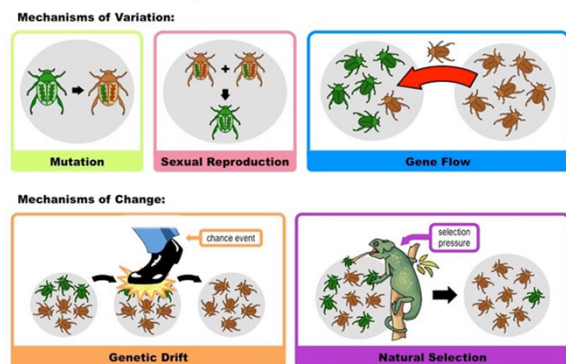
Recommended research

Genetic Drift
https://www.youtube.com/watch?v=W0TM4LQmoZY

Population Genetics: When Darwin Met Mendel
https://www.youtube.com/watch?v=WhFKPaRnTdQ

Amish founder effect
https://www.youtube.com/watch?v=N2ox8g4uQqc

Cheetah bottleneck effect
https://www.youtube.com/watch?v=HdtxnzwzgaQ

Selection of HSC questions from work booklet

Mod 6 – Question 3

The following events occur after DNA is subjected to radiation. The events are listed in no specific order.

P: Mutation
Q: Change in cell activity
R: Change in protein structure
S: Change in polypeptide sequence

What is the correct sequence of steps?

A. P, Q, R, S

B. S, Q, P, R

C. S, R, Q, P

D. P, S, R, Q

Mod 6 – Question 4

Which of the following is true of a mutation that produces an allele that is dominant?

A. It would be expected to cause death.

B. It could give an observable phenotype in a heterozygous genotype.

C. It could give an observable phenotype only in a homozygous genotype.

D. It would be expected to spread more quickly through a population than a recessive mutation.

Mod 6 – Question 8 (8 marks)

The flow chart illustrates the effect of a point mutation on an organism.

Stage: 1   2   3   4   5

CTGAGA → CTGTGA → GUCACU → [ ] → Faulty protein
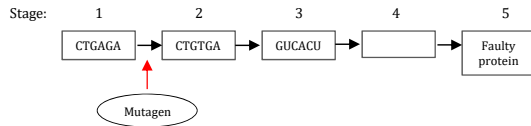
Mutagen

(a) Outline the series of events from stages 2 to 4 that resulted in the faulty protein.   3

(b) Describe how a type of mutagen may have caused the changes observed in stage 2.   2

(c) Given the information in the chart shown, describe the effect caused by the mutation in stage 4 and the effect this would have on the organism.   3

Characteristics and features

Requires a named example

Requires comparison of with and without the mutation
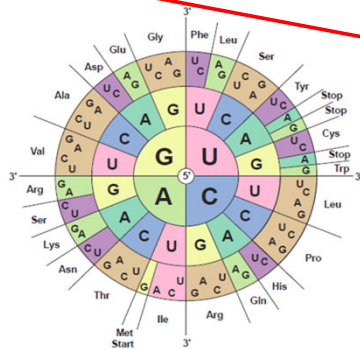
Question 22 (8 marks)

The diagram shows two steps of the process of meiosis occurring in a cell with four chromosomes.
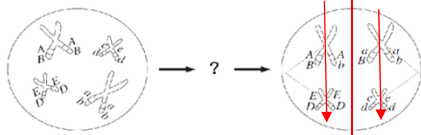
(a) Describe the behaviour of the chromosomes between the steps shown.   2

(b) List FOUR possible combinations of alleles that would be found in the gametes resulting from this process.   2

(c) Explain ONE advantage of the process of meiosis to the species.   2

(d) Distinguish between the terms *allele* and *gene*.   2
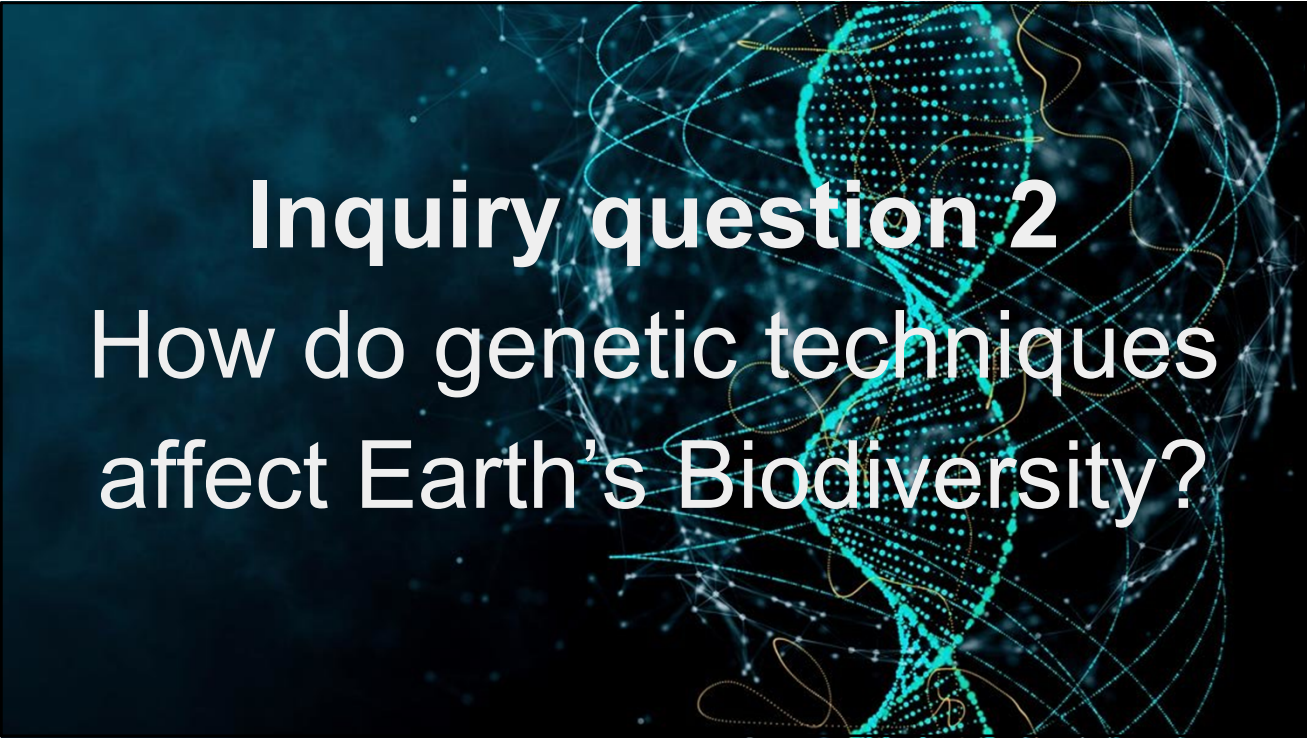
Crossing over on its own will only get you 1 mark

Exchange in arms of chromatids of homologous chromosomes → swapping of segment of chromosome

Answer should come from here- lines indicate where chromosomes separate at each anaphase/telophase

Cause and effect relationship must be shown
Cause: should relate to variation (new combinations of alleles being inherited together
Effect- should refer to survival advantage

Need to indicate DIFFERENCE between them- good to use an example to support your answer here

Inquiry question 2
How do genetic techniques affect Earth's Biodiversity?

Outcome 13.2a.

Investigate the uses and applications of biotechnology (past, present and future), including:
- **analysing** the social implications and ethical uses of biotechnology, including plant and animal examples
- **researching** future directions of the use of biotechnology
- **evaluating** the potential benefits for society of research using genetic technologies
- **evaluating** the changes to the Earth's biodiversity due to genetic techniques

Biotechnology

Biotechnology is the manipulation of organisms or their components to produce useful products.

Examples include:
- Selective breeding
- Artificial pollination and insemination
- Cloning
- Transgenesis (GMO's)
- Techniques including PCR and gel electrophoresis

Worth a watch – Biotechnology:
https://www.youtube.com/watch?v=SnkHmwTKksQ

- **Define** biotechnology
- **Identify** and **describe** applications of biotechnology (give plant and animal examples)
  - past e.g. selective breeding (corn, chicken), antimalarial drugs (cinchona plant) aquaculture (use by aboriginal people), artificial pollination, bacterial fermentation of food (rice wine)
  - present - aquaculture, antibiotics (penicillin), bacterial fermentation on a industrial scale (alcoholic beverages), genetic engineering (transgenic species-plant and animal examples), biofabrication, stem cells
  - future - CRISPR (medicine and designer babies), 3D printing (larger scale)
- **Define** the term ethics
- **Discuss** (give points for and against) the use of biotechnology in plants and animals.
- **Justify** arguments for the use of biotechnologies in plants and animals
- **Justify** the arguments against the use of biotechnologies
- **Justify** (explain and give reasons for) the benefits to society for the continued research into genetic technologies IMPORTANT TO ACCESS HIGHER BANDS
  - medical purposes (clinical trials for diseases such as cystic fibrosis, deletion of faulty genes)
  - effects on economy
  - effects on health care systems
  - effects on families living with genetic disorders
- **Discuss** how biotechnologies have resulted in changes in genomes of species- IMPORTANT TO ACCESS HIGHER BANDS
  - has it increased or decreased biodiversity?
  - effects in short term and long term
  - give an explicit judgement as to the benefit or detriment of using biotechnologies to Earth's biodiversity- make sure to justify your judgement (support with evidence)

Selection of HSC questions from work booklet

Sample HSC Question: Mod 6 – Question 10 (6 marks)

'The application of reproductive technologies in plant and animal breeding limits genetic diversity.'

To what extent is this statement correct?

Requires example of each

Requires multiple technologies. Name and describe

Link each reproductive technology to explicit explanation of how they limit genetic diversity

Stronger students will show TWO sides to the argument

Assess- requires judgement based on the examples and evidence

Inquiry question 3
Does the artificial manipulation of DNA have the potential to change populations forever?

Outcome 13.3a.

Investigate the uses and advantages of current genetic technologies that induce genetic change

Outcome 13.3b.

Compare the processes and outcomes of reproductive technologies, including but not limited to:
- artificial insemination
- artificial pollination

- **Draw** a table (ideal)
- **Identify** and outline features of processes of artificial insemination and artificial pollination (types of gametes, reproductive organs, method of transfer of gametes etc) (can be done on vertical or horizontal axis of graph)
- **Identify** and outline outcomes of reproductive technologies (effects on gamete production, variation etc)
- **Identify** specific examples of organisms used for these processes and for what reason
- **Show** similarities and differences between the processes and outcomes of these technologies

Only a sample of examples to include	ARTIFICIAL POLLINATION	ARTIFICIAL INSEMINATION
Description of method		
Outcome of process		
Similarities between artificial pollination and artificial insemination		
Differences between artificial pollination and artificial insemination		

Outcome 13.3c.

Investigate and **assess** the effectiveness of cloning, including but not limited to:
- whole organism cloning
- gene cloning

Present (future) biotechnology- Animal cloning

1 organism to be cloned

2n Somatic body cell (diploid)

Nucleus removed 2n

Nucleus fused with denucleated egg cell 2n

(CLONE of 1)

3 surrogate mother

cloned babies of organism **1**

Nucleus removed and discarded

2 doner organism

n unfertilised egg (haploid)

denucleated egg

Click and clone interactive:
https://learn.genetics.utah.edu/content/cloning/clickandclone/

- **Define** the term cloning
- **Describe** the process of whole organism cloning (in animals and plants)
  - Somatic cell nuclear transfer (dolly the sheep)
  - embryo splitting
  - tissue culture propagation in plants (wollemi pine)
- **Describe** the effect of cloning of the genetic makeup of populations (short term and long term) - refer to biodiversity
- **Discuss** the advantages and disadvantages of whole organism cloning in plants and animals - justify your arguments
- **Describe** the processes involved in gene cloning (PCR, restriction enzymes, ligases etc)
- **Describe** the effects of gene cloning of genetic makeup up of populations (short term and long term) - refer to biodiversity
- **Discuss** the advantages and disadvantages of gene cloning in plants and animals-justify your arguments
- give an explicit judgement as to the effectiveness of cloning- is cloning a beneficial/effective - JUSTIFY your judgement with evidence- important for a band 6 response

Outcome 13.3d.

Describe techniques and applications used in recombinant DNA technology, for example:
- the development of transgenic organisms in agricultural and medical applications

---

- Covered this in module 5:

- **Define recombinant DNA technology** (joining together of **DNA** molecules from two different species. The recombined **DNA** molecule is inserted into a host organism to produce new genetic combinations that are of value to science, medicine, agriculture, and industry.)

- Describe the techniques used in transgenesis

- Provide examples of agricultural applications (e.g. Bt Cotton)

- Provide examples used in medical application (e.g. human insulin production)

Present (future) biotechnology- Transgenesis (GMO's)
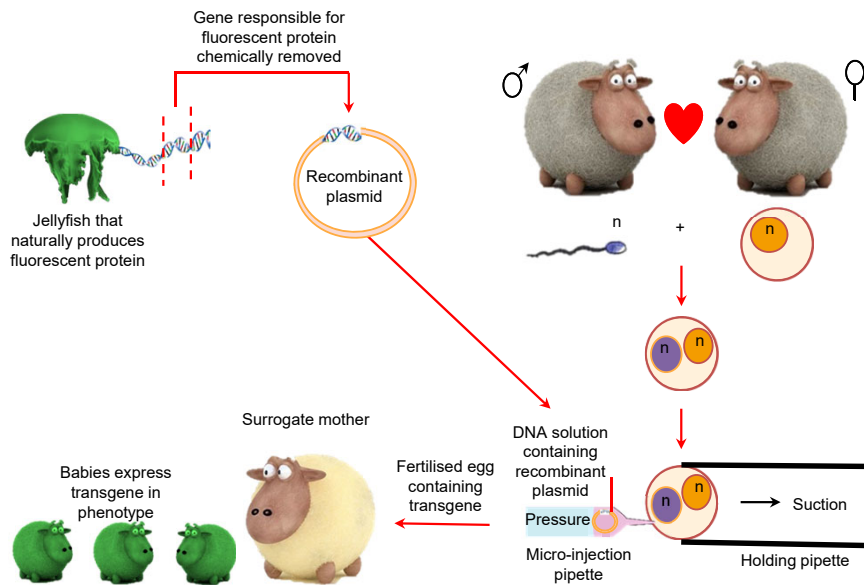
Outcome 13.3e.
Evaluate the benefits of using genetic technologies in agricultural, medical and industrial applications

Outcome 13.3f.
Evaluate the effect on biodiversity of using biotechnology in agriculture

Outcome 13.3g.
Interpret a range of secondary sources to assess the influence of social, economic and cultural contexts on a range of biotechnologies

- <mark>relate knowledge and understanding to **secondary sources** - important to use information from data presented in order to access BAND 6 response</mark>
- **Define** biotechnology
- **Describe** detailed examples of biotechnologies used for a variety of purposes (agriculture, medicinal)
- **Justify** the social influences of uses of specific biotechnologies
    - specific needs of society (is it really targeted in this way?)
    - choices made by government
    - SES of individuals
    - SES of country
    - cohorts used for clinical trials (are these biased?)
- **Justify** the economic influences of uses of specific biotechnologies
    - patents on technologies (control of access and costs)
    - unequal access (SES)
    - cost to consumers (agriculture-access to food)
- **Justify** the cultural contexts of uses of specific biotechnologies
    - religious beliefs and uses of technologies
    - moral beliefs (vegans, vegetarians)
    - educational background (accept or reject use of biotechnologies)

Selection of HSC questions from work booklet

2014 Q16

What is the best explanation for the successful development of transgenic species?

A. Artificial pollination works across the plant kingdom.

B. Nuclear transplantation from cell to cell is easily achieved.

C. DNA in the biosphere is composed of the same chemical components.

D. Genes from different animals within the one species are easily combined.

2008 Q3

To protect a farm animal from a plant toxin, a gene for resistance to the toxin was transferred to the farm animal.

Which term best describes this process?

A. Cloning

B. Genetic engineering

C. Artificial pollination

D. Artificial insemination

Sample HSC Question: Mod 6 – Question 6 (1 marks)

Glofish are a genetically-modified organism in which the gene that causes fluorescence in jellyfish has been inserted into a tropical fish species, typically Zebrafish. These fish are sold commercially for home aquariums. Some sectors of the community have said that humans do not have the right to make genetically-modified organisms for this purpose.

What is the main nature of their concern?

A. The limited application the Glofish have in society

B. The risks to the biodiversity of the Zebra fish species

C. The ethics of manipulating an organism's genes for commercial gain

D. That the Glofish may interbreed with other species causing serious mutations in the future

---

(d)   Construct a flow chart to show how an animal with a diploid number of 32 chromosomes can be cloned and how the clone can be verified. Include reference to chromosome number in each step.

5

Must include 3 or more steps with **ARROWS** in between each step

Need to show resulting **number of chromosomes** before and after cloning

Reference the number of chromosomes in each step

Must identify and outline a **technology** that can be used to show that original and cloned animal are **exactly the same genetically**

DNA fingerprinting or sequencing

Egg cell
16
0   Egg cell nucleus removed
32
32   Skin cell nucleus transferred
Implanted into surrogate mother
32   Growth   Clone is born
DNA fingerprinting

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IGNITING NEW WAYS OF LEARNING
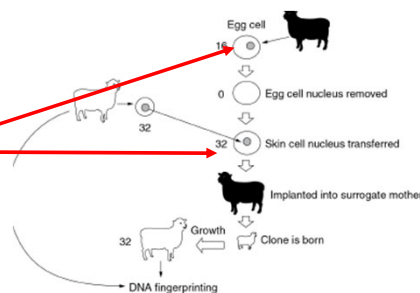
HSC Study day – Biology Sessions
Module 7 Infectious disease

Dr Silvia Rudmann

silvia.rudmann@det.nsw.edu.au

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Module 7 – Infectious diseases

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Outcomes
- develops and evaluates questions and hypotheses for scientific investigation BIO11/12-1
- designs and evaluates investigations in order to obtain primary and secondary data and information BIO11/12-2
- conducts investigations to collect valid and reliable primary and secondary data and information BIO11/12-3
- selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media BIO11/12-4
- analyses infectious disease in terms of cause, transmission, management and the organism's response, including the human immune system BIO12-14

Module 7 – Infectious diseases

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Outcomes
- **develops and evaluates questions and hypotheses** for scientific investigation BIO11/12-1
- **designs and evaluates investigations** in order to obtain primary and secondary data and information BIO11/12-2
- conducts investigations to **collect valid and reliable** primary and secondary data and information BIO11/12-3
- selects and **processes appropriate qualitative and quantitative data** and information using a range of appropriate media BIO11/12-4
- **analyses** infectious disease in terms of cause, transmission, management and the organism's response, including the human immune system BIO12-14

Module 7 – Infectious diseases

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Brief concept map of ideas

Module 7 – Infectious diseases
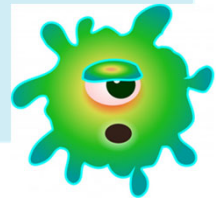
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Inquiry questions in this module:

- *How are disease transmitted?*
- *How does a plant or animal respond to infection?*
- *How does the human immune system respond to exposure to a pathogen?*
- *How can the spread of infectious diseases be controlled?*

Module 7 – Infectious diseases

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Verbs in this m

Investigate
Plan, inquire into and draw conclusions about

assess
interpret explain
evaluate classify
compare
investigate
describe
analyse

10/15 content statements are 'investigate'

Module 7 – Infectious diseases

Investigations

Investigate
Plan, inquire into and draw conclusions about

- investigating the transmission of a disease during an epidemic.
- investigate the work of Robert Koch and Louis Pasteur, to explain…..
- investigate the response of a named Australian plant to a named pathogen…..
- investigate and model the innate and adaptive immune systems
- investigate and analyse the wide range of interrelated factors……involved …. Spread of disease
- investigate procedures that can be employed to prevent the spread ….
- investigate and assess the effectiveness of pharmaceuticals…
- investigate and evaluate environmental management….
- investigate the contemporary application of Aboriginal protocols…

Module 7 – Infectious disease

General tips for this module

- Answer all the inquiry questions by using the content statements as evidence
- Focus on the verbs to answer those questions
- Learn ONE example well but know the others too
- Relate ALL the outcomes to the 'story' of disease
- Don't forget good biology and correlation and integration between content gives you the best marks

Module 7 – Infectious disease

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History and culture, aboriginal medicine → Pathogens → Transmission

Immune response: plants and animals ← Effect on agriculture ← Understanding: Pasteur and Koch

The 'story of infectious diseases

Treatments: procedure → Control: procedures → Data: prevention and control
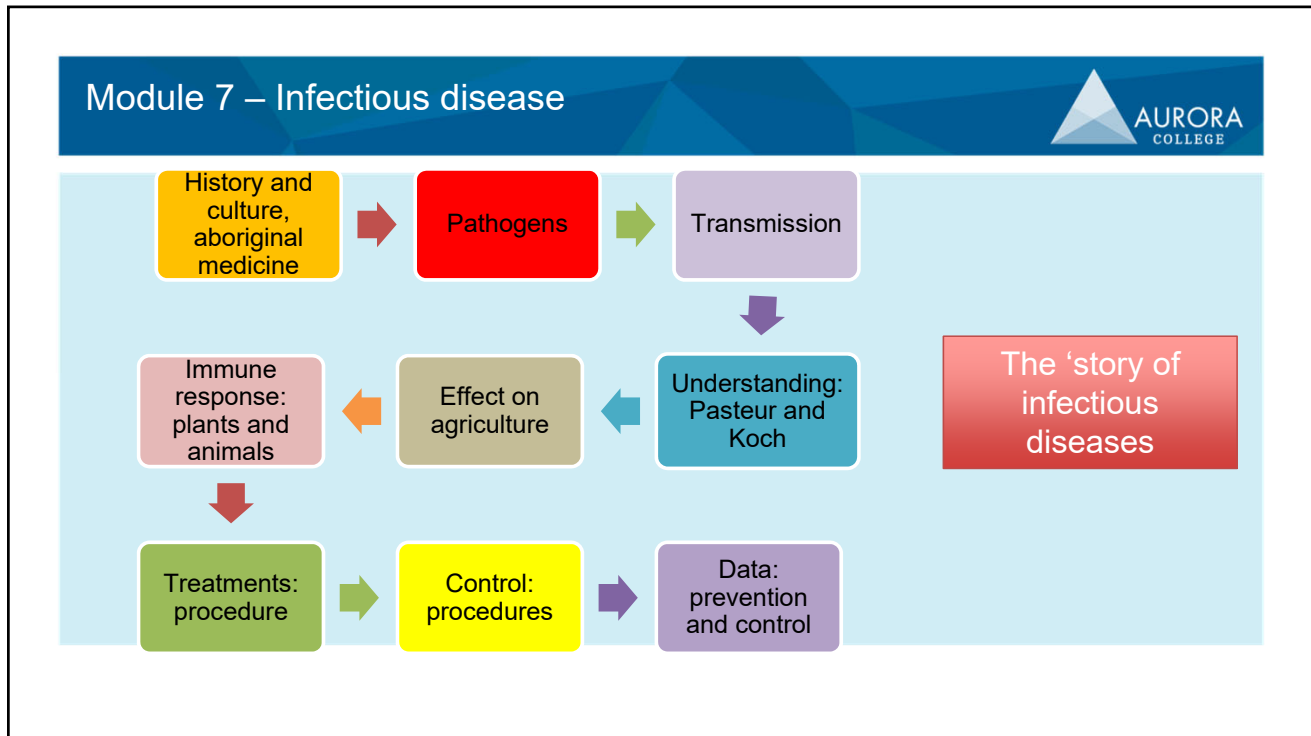
Module 7 – Infectious disease

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- *How does the human immune system respond to exposure to a pathogen?*
- *How can the spread of infectious diseases be controlled?*

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- *How are diseases transmitted?*
  - Pathogens: classification, characteristics, transmission adaptations
  - Pasteur and Koch work: helped to identify pathogens and procedures for treatments
  - Causes and effects on transmission: epidemics and agriculture cases

Module 7 – Infectious disease

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- *How does a plant or animal respond to infection?*

  - Responses of Australian plants: learn ONE well fungal or viral pathogens but know all of them
  - Responses of animals: physical and chemical changes

Module 7 – Infectious disease

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- *How does the human immune system respond to exposure to a pathogen?*

  – Model innate and acquired immunity
  – Primary exposure to a pathogen

Module 7 – Infectious disease

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- *How can the spread of infectious diseases be controlled?*

  – Spread factors
  – Prevention strategies
  – Use of pharmaceuticals: antivirals and antibiotics
  – Management: environment and quarantine
  – Incidence and prevalence – Malaria, Dengue, mobility and immunised of humans
  – History and cultural strategies to control the spread of disease
  – Aboriginal protocols to develop medicines and biological materials

Module 7 – Infectious diseases

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Exam type questions
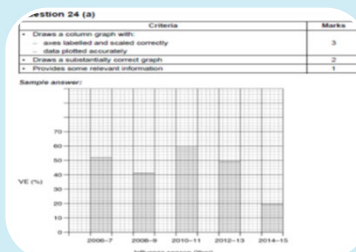
Content

Skills
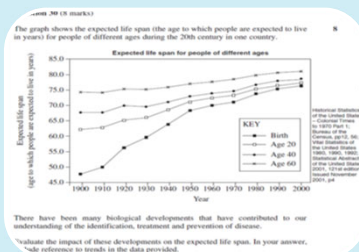
Integrating modules

Module 7 – Infectious diseases

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- Exam type questions – Content *(Paper 2019)*

1 Which of the following is an example of a non-infectious disease?

   A.   Polio caused by a virus

   B.   Cholera caused by a bacterium

   C.   Wheat rust caused by a fungus

   D.   Haemophilia caused by a gene mutation

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- Exam type questions – Content *(Paper 2018)*

8 An organism suspected of causing a disease is described as being unicellular, having a cell wall and lacking a nucleus.

How is this organism classified?

A. A bacterium

B. A fungus

C. A protozoan

D. A virus

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- Exam type questions – Content *(Paper 2019)*

Question 31 (5 marks)

(a) Outline ONE adaptation of a specific pathogen that facilitates its entry into a host.   2

Question 31 (a)

Criteria	Marks
• Outlines one adaptation that facilitates entry of a specific pathogen into its host	2
• Provides some relevant information	1

Module 7 – Infectious diseases

- **Exam type questions – Content** *(Paper 2019)*

Question 31 (5 marks)

(a)   Outline ONE adaptation of a specific pathogen that facilitates its entry into a host.   **2**

Sample answer:

The bacterium *Helicobacter pylori* causes stomach ulcers in humans. It has a flagellum that allows it to move and penetrate the mucus lining/barrier of the stomach wall.

Module 7 – Infectious diseases

- **Exam type questions – Skills** *(Paper 2019)*

10   A group of islands are separated from each other by large stretches of water. Each island has its own policy on quarantine.

A nearby country is experiencing an outbreak of an infectious disease in its cattle.

An investigation is to be designed to find which of the quarantine policies operating on the islands is the most effective.

Which of the following would be a suitable design feature of the investigation?

A.   The control is the smallest island.

B.   The control is the number of infected cattle.

C.   The independent variable is quarantine policy.

D.   The independent variable is the number of infected cattle.

Module 7 – Infectious diseases

Exam type questions
Skills *(Paper 2018)*

Question 24 (6 marks)

A new flu vaccine is prepared each year to protect the population against the current strains of influenza virus. The effectiveness of flu vaccines varies from year to year and can be measured using the overall vaccination effectiveness (VE) index. A VE of 60% means that a vaccinated individual's chance of getting the flu is reduced by 60%.

The following data show the VE over a 10-year period.

Influenza season	VE (%)
2006–2007	52
2008–2009	41
2010–2011	60
2012–2013	49
2014–2015	19

(a)   Draw an appropriate graph to represent the data on the following grid.   3

Module 7 – Infectious diseases

Exam type questions
Skills *(Paper 2018)*

Question 24 (a)

Criteria	Marks

• Draws a column graph with:
  – axes labelled and scaled correctly
  – data plotted accurately
	3

• Draws a substantially correct graph	2
• Provides some relevant information	1

Sample answer:
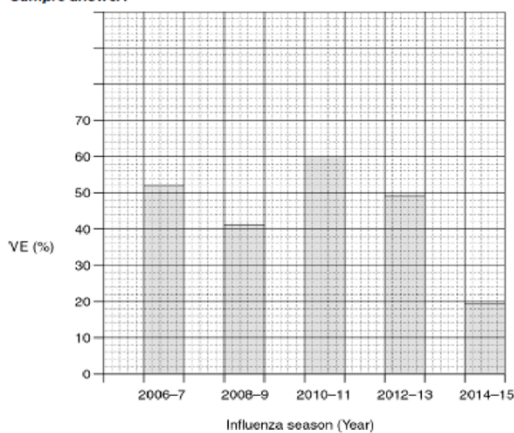
Module 7 – Infectious diseases

Exam type questions – Skills *(Sample Paper 2019)*

Marking guidelines:

Criteria	Marks
• Correctly completes the table	3
• Shows how some relevant risks can be minimised	2
• Shows how a relevant risk can be minimised	1

Sample answer:

Risk	Procedure to minimise it
Cross-contamination from bench	Use antiseptic to clean bench and work area
Growth of microbes harmful to humans	Incubate agar plates at below 35°C, so microbes dangerous to humans will not grow
Infection	Wear protective clothing, eg gloves, masks, lab coat

Mod 7 – Question 13 (3 marks)

A practical investigation is to be carried out to test for the microbes found in food.   3

Complete the table to show how to minimise risks that are likely to arise in carrying out this investigation.

Risk	Procedure to minimise it

Module 7 – Infectious diseases

- Exam type questions – Models *(Sample Paper 2019)*

Mod 7 – Question 3

The diagram shows a model of disease transmission.
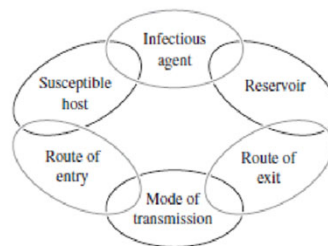
An epidemiologist suspected that bats were acting as a reservoir for an infectious disease in humans.

Which condition would need to be met to confirm the epidemiologist's suspicion?

A.   The infectious agent would need to have a mode of entry into humans.

B.   The infectious agent would need a mode of transmission from bats to humans.

C.   The bats would have to be able to transmit the infectious agent between each other.

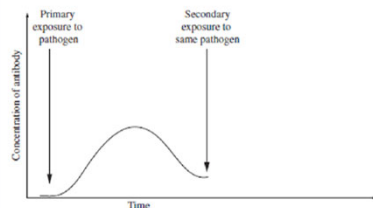D.   The susceptible human host must be able to transmit the infectious agent to the reservoir of bats.

Module 7 – Infectious diseases

Exam type questions
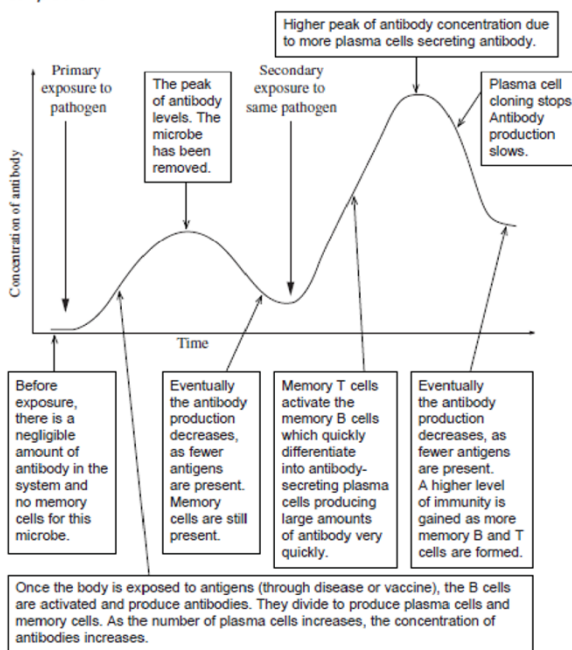Annotated diagrams/graphs *(Sample Paper 2019)*

Mod 7 – Question 16 (6 marks)

The diagram shows the immune response after primary exposure to a pathogen.

(a) On the diagram, continue the graph to show the immune response upon secondary exposure to the same pathogen.   2

(b) Using annotations on the diagram, explain the shape of the entire graph.   4

Sample answer:

Higher peak of antibody concentration due to more plasma cells secreting antibody.

Plasma cell cloning stops. Antibody production slows.

The peak of antibody levels. The microbe has been removed.

Before exposure, there is a negligible amount of antibody in the system and no memory cells for this microbe.

Eventually the antibody production decreases, as fewer antigens are present. Memory cells are still present.

Memory T cells activate the memory B cells which quickly differentiate into antibody-secreting plasma cells producing large amounts of antibody very quickly.

Eventually the antibody production decreases, as fewer antigens are present. A higher level of immunity is gained as more memory B and T cells are formed.

Once the body is exposed to antigens (through disease or vaccine), the B cells are activated and produce antibodies. They divide to produce plasma cells and memory cells. As the number of plasma cells increases, the concentration of antibodies increases.

Module 7 – Infectious diseases

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- Exam type questions – Across modules/skills *(Paper 2018)*

Refer to the following information to answer Questions 19 and 20.

Melanomas are characterised by uncontrolled cell division caused by mutations that continue to occur once the tumour has developed. Scientists have discovered that vaccines produced using antigens extracted from the patient's own melanoma cells can be useful in treating melanoma. When injected, the vaccines stimulate an immune response.

19   What can be inferred from the scientists' discovery?

(A)   Cancer cells carry unique antigens.

(B)   Self-antigens are not present on cancer cells.

(C)   The melanoma patient has a dysfunctional immune system.

(D)   The body cannot mount an immune response against cancer cells.

20   The effect of the melanoma vaccine is to stimulate

(A)   T cells which produce antibodies.

(B)   cytotoxic T cells which activate B cells.

(C)   cell division to produce more lymphocytes.
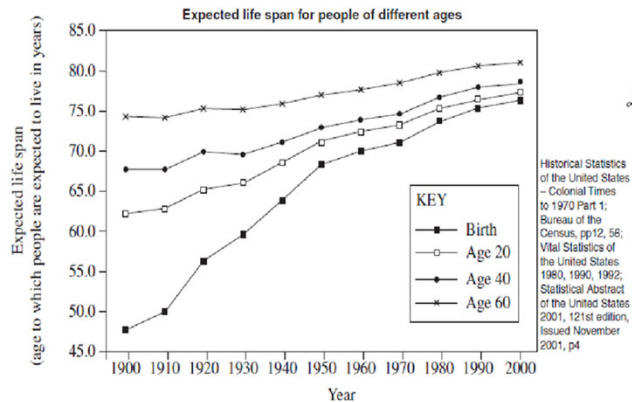
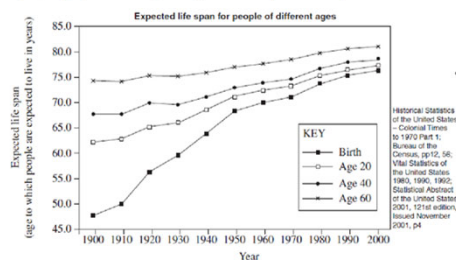(D)   production of B cells which destroy melanoma cells.

Module 7 – Infectious diseases

Exam type questions
Across modules/skills
(Paper 2018)

Question 30 (8 marks)

The graph shows the expected life span (the age to which people are expected to live in years) for people of different ages during the 20th century in one country.

8

Expected life span for people of different ages

KEY
- ■ Birth
- □ Age 20
- ● Age 40
- × Age 60

Historical Statistics of the United States – Colonial Times to 1970 Part 1; Bureau of the Census, pp12, 56; Vital Statistics of the United States 1980, 1990, 1992; Statistical Abstract of the United States 2001, 121st edition, Issued November 2001, p4

There have been many biological developments that have contributed to our understanding of the identification, treatment and prevention of disease.

Evaluate the impact of these developments on the expected life span. In your answer, include reference to trends in the data provided.

Module 7 – Infectious diseases

Exam type questions
Across modules/skills *(Paper 2018)*

Question 30

Criteria	Marks
• Analyses the data to draw suitable conclusions • Demonstrates an extensive understanding of the development of the identification, treatment and prevention of disease • Links trends in the data to specific developments in identifying, treating and preventing disease • Synthesises information to draw a suitable conclusion/judgement about the impact of biological developments on life span • Uses precise biological terms	8
• Analyses the data to provide key trends • Demonstrates a thorough understanding of the development of the identification, treatment and prevention of disease • Links trends in the data to specific developments in identifying, treating and preventing disease • Provides a clear judgement about the impact of biological developments on life span • Uses suitable biological terms	6–7
• Provides a trend in the data • Demonstrates a sound understanding of the development of our understanding of disease • Links the data to developments in understanding disease • Uses some suitable biological terms	4–5
• Describes the data • Demonstrates some understanding of the development of our understanding of disease • Links data to understanding disease	2–3
• Provides some relevant information	1

Module 7 – Infectious diseases

Exam type questions
Across modules/skills *(Paper 2018)*

Question 30 (8 marks)

The graph shows the expected life span (the age to which people are expected to live in years) for people of different ages during the 20th century in one country.

Expected life span for people of different ages

KEY
- Birth
- Age 20
- Age 40
- Age 60

Historical Statistics of the United States – Colonial Times to 1970 Part 1; Bureau of the Census, pp12, 56; Vital Statistics of the United States 1989, 1990, 1992; Statistical Abstract of the United States 2001, 121st edition, Issued November 2001, p4

There have been many biological developments that have contributed to our understanding of the identification, treatment and prevention of disease.

Evaluate the impact of these developments on the expected life span. In your answer, include reference to trends in the data provided.

Sample answer:

The graph shows that life span has increased for all ages over the last century. The younger the individual the greater the increase in life span. Life span at birth has increased dramatically from 48 years to 75 years. At other ages it has increased less (12 years for 20-year-olds, 10 years for 40-year-olds and the smallest increase of five years for 60-year-olds).

Being able to identify the cause of diseases such as measles, rubella and whooping cough is the result of our developing an understanding of pathogens as the cause of infectious disease through the work of Pasteur and Koch. They developed germ theory and a set of rules/postulates and culture techniques to be followed in establishing the link between a specific pathogen and disease. Knowledge of pathogens led to the development of vaccines (incorporating harmless versions of pathogens) that can be used to prevent common childhood diseases. Vaccines provide active immunity to specific pathogens. This has significantly reduced the number of deaths in young children resulting in a dramatic increase in their life expectancy.

Understanding bacterial pathogens and differences between prokaryotic and eukaryotic cells has led to the development of antibiotic treatments for pathogens such as *Staphylococcus aureus*. This means many infections can be treated instead of being life threatening. This has resulted in improved life span at all ages. However, the overuse of antibiotic treatment

---

Summary

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01 — Inquiry questions
- Answer each of them by applying the content statements as evidence

02 — Verbs
- Know what is expected to write under that verb
- Don't forget your 'judgement' in evaluate, assess, justify

03 — Integration and correlation
- Integrate your knowledge across the module
- Correlate ideas and solutions to problems
- Apply what you know about Biology in the context

04 — Skills
- Investigation process
- Graphs and tables
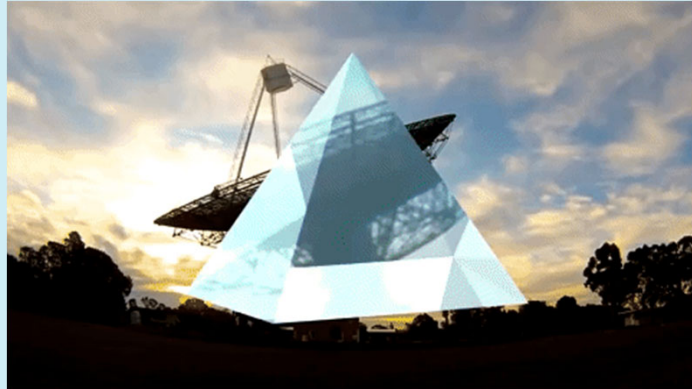- Annotations of models and graphs

05 — Practice from previous papers
- All papers are good to practice
- Read the marking guidelines and you will know what outcomes are targeted

Good luck!

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HSC Study day – Biology Sessions
Module 8 Non-infectious disease and disorders
Dr Silvia Rudmann

silvia.rudmann@det.nsw.edu.au

Module 8 – Non-infectious disease and disorders

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Outcomes
- analyses and evaluates primary and secondary data and information BIO11/12-5
- solves scientific problems using primary and secondary data, critical thinking skills and scientific processes BIO11/12-6
- communicates scientific understanding using suitable language and terminology for a specific audience or purpose BIO11/12-7
- explains non-infectious disease and disorders and a range of technologies and methods used to assist, control, prevent and treat non-infectious disease BIO12-15

Module 8 – Non-infectious disease and disorders

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Outcomes

- **analyses and evaluates** primary and secondary **data** and information BIO11/12-5
- **solves scientific problems** using primary and secondary data, **critical thinking skills and scientific processes** BIO11/12-6
- communicates scientific understanding using **suitable language and terminology** for a specific audience or purpose BIO11/12-7
- **explains** non-infectious disease and disorders and a range of technologies and methods used to assist, control, prevent and treat non-infectious disease BIO12-15

Module 8 – Non-infectious disease and disorders

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Brief concept map of ideas

Module 8 – Non-infectious disease and disorders

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Inquiry questions in this module

- How is an organism's internal environment maintained in response to a changing external environment?
- Do non-infectious diseases cause more deaths than infectious-diseases?
- Why are epidemiological studies used?
- How can non-infectious diseases be prevented?
- How can technologies be used to assist people who experience disorders?

Module 8 – Non-infectious disease and disorders

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Verbs in this module

Investigate
Plan, inquire into and draw conclusions about

Module 8 – Non-infectious disease and disorders

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Investigations:

- investigate the various mechanisms used by organisms to maintain their internal environment within tolerance limits…
- investigate the causes and host responses of non-infectious diseases in humans
- investigate the treatment/management, and possible future directions for further research, of a non-infectious disease using an example….
- investigate technologies that are used to assist with the effects of a disorder

Module 8 – Non-infectious disease and disorders

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General tips for this module
- Answer all the inquiry questions by using the content statements as evidence
- Focus on the verbs to answer the questions
- Learn ONE example well
- Relate ALL the outcomes to the 'story' of non-infectious disease
- Don't forget good biology and integration of content gives you the best marks
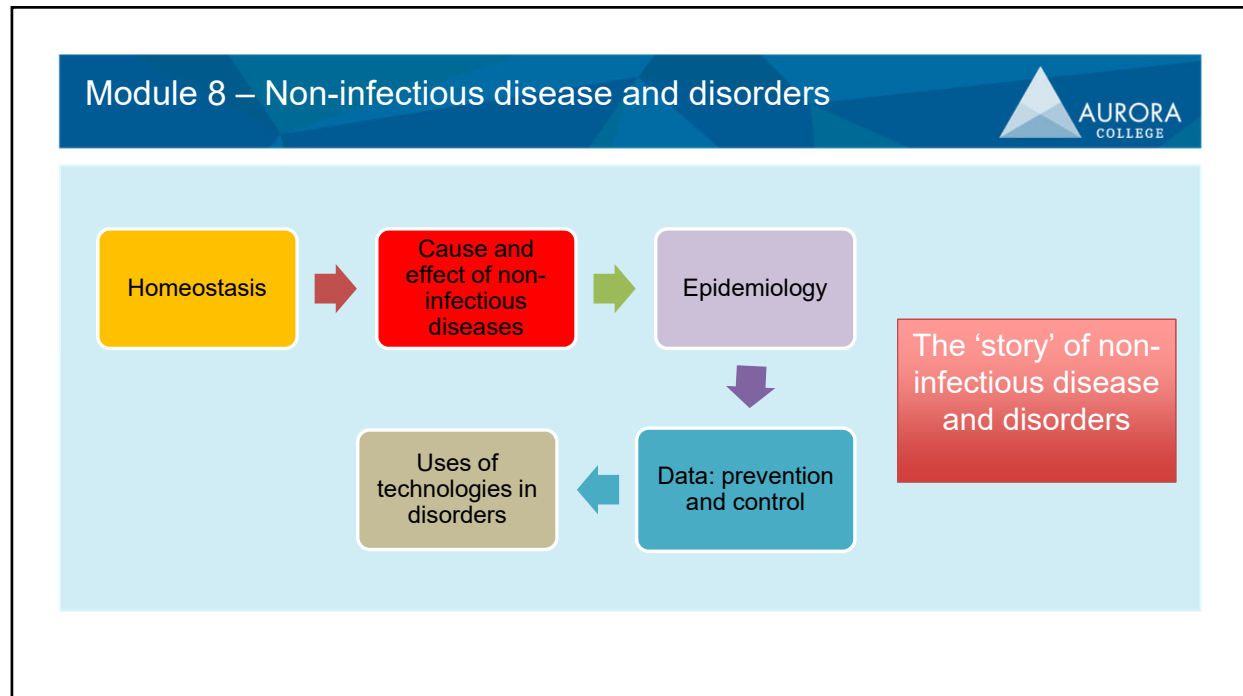
Module 8 – Non-infectious disease and disorders

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Homeostasis → Cause and effect of non-infectious diseases → Epidemiology

Uses of technologies in disorders ← Data: prevention and control

The 'story' of non-infectious disease and disorders

Module 8 – Non-infectious disease and disorders

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Inquiry questions in this module

- How is an organism's internal environment maintained in response to a changing external environment?
- Do non-infectious diseases cause more deaths than infectious-diseases?
- Why are epidemiological studies used?
- How can non-infectious diseases be prevented?
- How can technologies be used to assist people who experience disorders?

Module 8 – Non-infectious disease and disorders

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- *How is an organism's internal environment maintained in response to a changing external environment?*
  - Negative feedback mechanisms
  - Homeostasis – temperature and glucose (sugar)
  - Mechanisms to maintain internal environment: trends and patterns in behaviours, structures and physiological adaptations
  - Hormones and nervous system
  - Water balance in plants

Module 8 – Non-infectious disease and disorders

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- *Do non-infectious diseases cause more deaths than infectious-diseases?*
  - Cause and effects of non-infectious diseases: genetic, environmental, nutritional, and cancer
  - Data: incidence, prevalence and mortality rates, learn ONE example

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- *Why are epidemiological studies used?*
  - Patterns of non-infectious diseases in populations
  - Investigate treatment and control strategies to prevent spread and future directions of research
  - Methodology of epidemiological studies
  - Benefits

QUARANTINE

Module 8 – Non-infectious disease and disorders

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- *How can non-infectious diseases be prevented?*
  - Effectiveness of current prevention methods and strategies:
    - Educational programs and campaigns, e.g, Quit
    - Genetic engineering, e.g. Malaria mosquito

Module 8 – Non-infectious disease and disorders

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- *How can technologies be used to assist people who experience disorders?*
  – Structure and function of ear, eye and kidney
  – Technologies that assist disorders
  – Effectiveness of the technology

Module 8 – Non-infectious disease and disorder

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Exam type questions

Content

Skills

Integrating modules

Module 8 – Non-infectious disease and disorder

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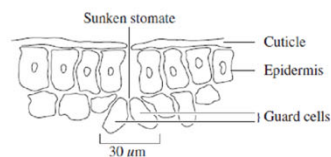
- Exam type questions – Content *(Paper 2019)*

> **6** How does the cochlear implant assist people with severe hearing loss?
>
> A. It amplifies sound.
> B. It stimulates the ear drum.
> C. It stimulates the auditory nerve.
> D. It amplifies vibrations in the cochlea.

Module 8 – Non-infectious disease and disorder

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- Exam type questions – Content *(Paper 2018)*

> **9** Sunken stomata can be found in the leaves of some Australian plants. A section of such a leaf is shown.
>
>
> Sunken stomate — Cuticle — Epidermis — Guard cells — 30 μm
>
> How do sunken stomata assist the plant to conserve water in a dry environment?
>
> A. They trap moist air, reducing humidity.
> B. They prevent entry of gases into the leaf.
> C. They accumulate moist air, reducing transpiration.
> D. They increase the surface area available for transpiration.

Module 8 – Non-infectious disease and disorders

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- **Exam type questions – Content** *(Paper 2015)*

16   Why might epidemiology be considered more essential for the study of non-infectious diseases than for the study of infectious diseases?

(A)   The causes of infectious diseases have already been determined.

(B)   Only non-infectious diseases are affected by patterns of behaviour.

(C)   Epidemiology cannot be used to find the causes of infectious diseases.

(D)   Koch's postulates are not useful in finding the causes of non-infectious diseases.

Module 8 – Non-infectious disease and disorders

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- **Exam type questions – Content** *(Paper 2019)*

Question 23 (5 marks)

Explain how educational programs can be effective in reducing the incidence of non-infectious diseases. Support your answer with examples.

5

Module 8 – Non-infectious disease and disorders

Exam type questions
Content *(Paper 2019)*

Question 23 (5 marks)

Explain how educational programs can be effective in reducing the incidence of non-infectious diseases. Support your answer with examples.   **5**

Question 23

Criteria	Marks
• Provides a thorough explanation of how educational programs reduce the incidence of non-infectious diseases • Supports answer with suitable examples	5
• Provides a sound explanation of how educational programs reduce the incidence of a non-infectious disease • Supports answer with suitable example(s)	4
• Provides some features of educational programs and links these to disease prevention • Provides a suitable example	3
• Provides some features or examples of educational programs that help prevent disease	2
• Provides some relevant information	1

Sample answer:

Name of disease:	*Program to prevent disease:*
Melanoma	Slip, slop, slap, seek, slide
Lung Cancer	Quit (smoking)

Public education programs can raise awareness of the risk of exposure to various harmful environmental agents. For example UV radiation can cause melanoma and tobacco smoke increases the risk of lung cancer. As a result of the programs, people can alter their behaviour to reduce their exposure to harmful situations. For example not everyone can avoid the sun in their daily lives but the program encourages them to wear a hat, shirt and sunscreen so that exposure to UV radiation is reduced. This reduces the risk of melanoma.

Module 8 – Non-infectious disease and disorders

Exam type questions
Content *(Paper 2018)*

Question 21 (4 marks)

(a) Identify TWO responses of a named endotherm to a decrease in body temperature.   **2**

....

....

....

(b) Outline the role of the nervous system of an endotherm in maintaining homeostasis when its body temperature changes.   **2**

Question 21 (a)

Criteria	Marks
• Identifies TWO appropriate responses in a named endotherm to a decrease in body temperature	2
• Provides some relevant information	1

Sample answer:

Shivering and vasoconstriction in humans.

Question 21 (b)

Criteria	Marks
• Outlines the role of an endotherm's nervous system in detecting and responding to temperature changes	2
• Provides some relevant information	1

Sample answer:

Changing body temperature is detected using temperature receptors in the skin and brain. A signal is sent via nerves from the receptors to the central nervous system. Nerve signals are then sent from the CNS to effectors (muscles or glands).

Module 8 – Non-infectious disease and disorders

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Exam type questions – Content *(Paper 2015)*

(e) 'Science is used to solve problems for the benefit of society.' **7**

Justify this statement with reference to the scientific knowledge used to solve ONE problem in hearing and ONE problem in visual accommodation.

Question 32 (e)

Criteria	Marks
• Demonstrates a thorough understanding of accommodation • Identifies a problem in visual accommodation • Explains a solution to the accommodation problem using scientific knowledge • Describes a benefit to society of using the solution to solve the problem in accommodation • Identifies a problem in hearing • Explains the solution to the hearing problem using scientific knowledge • Describes a benefit to society of applying the solution to the problem in hearing	7

Module 8 – Non-infectious disease and disorders

- Exam type questions – Content *(Paper 2015)*

(e) 'Science is used to solve problems for the benefit of society.' 7

Justify this statement with reference to the scientific knowledge used to solve ONE problem in hearing and ONE problem in visual accommodation.

Sample answer:

Problems with hearing and vision pose a problem for society because they limit a person's ability to function normally in jobs or at home.

Such problems limit the ability of people to communicate, which can cause personal distress and limit their capacity to contribute to society. By overcoming these problems, both individuals and society benefit. When these problems are solved, people can continue to make an economic contribution. Additionally, they will not need carers, which may be costly to the public.

One problem in hearing: limited transmission of sound through the ear

Deafness can be due to failure of sound waves to produce vibrations in the tympanic membrane because of inadequate transmission through the ear canal. The mechanical energy of the vibration is transferred to the cochlea where it is transformed into action potentials that are transmitted into the cerebrum to allow sound to be perceived. A hearing aid works by amplifying the sound waves within the ear canal, increasing the energy being transmitted through the ear. In order to develop this technology, scientists relied on their understanding of the role of the eardrum and the science of electronics, which enabled them to produce a small amplifier.

One problem in accommodation: myopia

Accommodation is the change of the shape of the lens to focus on near or far objects. Without accommodation problems sharp images of objects at any distance can be focused on the retina.

One problem with accommodation arises when the lens cannot focus a clear image on the retina due to an elongated eyeball. Light rays converge in front of the retina. No clear image of distant objects is seen. This is called myopia.

The solution is to use another lens (concave) outside the eye to cause the light rays to bend before they move into the lens of the eye. This allows the light rays to converge on the retina allowing the person to see sharp images of distant objects.

Module 8 – Non-infectious disease and disorders

Exam type questions:

Annotated graphs
(Sample Paper 2019)

Mod 8 – Question 10 (6 marks)

Glucose is a chemical that must be maintained at concentrations between 70 to 130 mg/dL in the blood in order for the body to function normally.

(a) Draw a diagram that illustrates how the body maintains blood glucose within this range. **3**

(b) Sketch a graph on the axes provided showing the expected blood glucose levels of both a healthy person and a diabetic person after consuming a fruit juice. On the same graph, show what would happen when the diabetic person injects themself with insulin 20 minutes after consuming the fruit juice. **3**

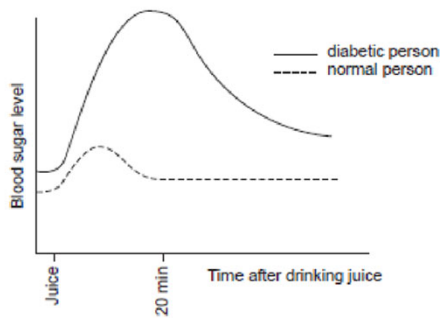## Module 8 – Non-infectious disease and disorders

Exam type questions

Annotated graphs *(Sample Paper 2019)*

Marking guidelines (b):

Criteria	Marks
• Provides correctly labelled axes and key • Draws representation of diabetic person with rapidly increasing blood glucose that decreases only after 20 minutes when insulin is taken • Draws representation of normal person with relatively low increase in blood glucose with decrease beginning before 20 minutes have elapsed	3
• Provides correctly labelled axes and key • Draws representation of diabetic person with rapidly increasing blood glucose in comparison to normal person	2
• Provides some relevant information	1

Sample answer:

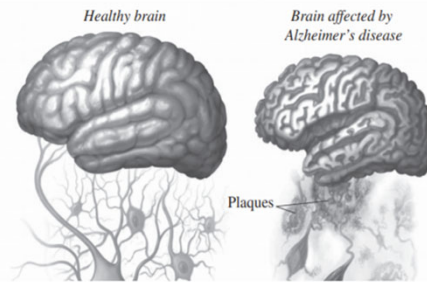## Module 8 – Non-infectious disease and disorders

Exam type questions

Integration of knowledge across modules
(Paper 2019)

Module 5 - DNA and polypeptide synthesis

Question 33 (20 marks)

Alzheimer's disease causes destruction of brain tissue, dementia and eventually death.

The diagram shows the effect of Alzheimer's disease on the brain.

Healthy brain

Brain affected by Alzheimer's disease

Plaques

Used with permission from Mayo Foundation for Medical Education and Research, all rights reserved

(a) Amyloid beta protein is produced in the human brain throughout life. In people with Alzheimer's disease, it accumulates in excessive amounts.

Outline the main steps that brain cells use to make proteins such as amyloid beta.

3

Module 8 – Non-infectious disease and disorders

Module 5 - Genetic variation

Exam type questions

Integration of knowledge across modules
(Paper 2019)

Module 8 - Epidemiology

Question 33 (continued)

(b) The gene with the greatest known effect on the risk of developing late-onset Alzheimer's disease is called APOE. It is found on chromosome 19.

The APOE gene has multiple alleles, including e2, e3 and e4.

(i) What are multiple alleles?

2

....
....
....
....

(ii) The table shows the risk of developing Alzheimer's disease for various APOE genotypes compared to average risk in the population.

4

APOE genotype	e2/e2	e2/e3	e2/e4	e3/e3	e3/e4	e4/e4
Risk of developing Alzheimer's disease (compared to average)	40% less likely	40% less likely	2.6 times more likely	Average	3.2 times more likely	14.9 times more likely

Risk of susceptibility, based on alleles. © Alzheimer.org

Analyse the data to assess the risk of developing Alzheimer's disease associated with the e2, e3 and e4 alleles.

Module 8 – Non-infectious disease and disorders

Exam type questions

Integration of knowledge across modules
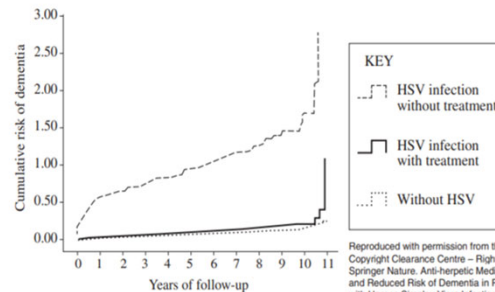*(Paper 2019)*

Module 8 - Epidemiology

Question 33 (continued)

(c) A large epidemiological study was conducted. It used historical data to investigate the association between *Herpes simplex* virus (HSV) infection and dementia. Dementia is caused by a variety of brain illnesses. Alzheimer's disease is the most common cause of dementia.

The study used the records of 8362 patients with HSV infection and 25 086 randomly selected sex- and age-matched control patients without HSV infection. Some of the patients with HSV had been treated with antiviral medication.

The graph below shows some results of the study.

KEY

⌐⌐ HSV infection without treatment

⌐ HSV infection with treatment

⋯ Without HSV

Reproduced with permission from the Copyright Clearance Centre – RightsLink: Springer Nature. Anti-herpetic Medications and Reduced Risk of Dementia in Patients with Herpes Simplex Virus Infections — a Nationwide, Population-Based Cohort Study in Taiwan. Fig 1 (Neurotherapeutics) Nian-Sheng Tzeng, Chi-Hsiang Chung, Fu-Huang Lin et al. © 2018

Describe the trends shown in the data.

Module 8 – Non-infectious disease and disorders

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Exam type questions

Integration of knowledge across modules
(Paper 2019)

Module 7 - Causes of Infectious diseases
Module 8 - Causes and effects
Module 8 - Epidemiology

Question 33 (continued)

(d) Diseases are classified as infectious or non-infectious.

Evaluate whether Alzheimer's disease should be classified as an infectious disease or a non-infectious disease. In your answer, include reference to the information and data provided throughout Question 33.

8

Summary

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45	Mruynv}$uyiwxnsrw	• Erw{iv$ruynv}$uyiwxnsrw$f}$ywnrkligsrxirx$ wxexiqirxewizmhirgi2
46	Zivfw	• Os{$}lex$w$l|tigxih$sjlierw{ivsvlex$zivf • Viqiq fiv$shhsyv$yhkiq irx$r$uyiwxnsrw{md$ izepyexi0$ewwiww0$ywxmj}
47	Ors{pihki	• Mxikvexisyvors{pihki$gvsww$li$shypiw • Ettp}$syv$ors{pihki$sri{svyrjeqmpev$mxyexnsr • Pievr$gewi$xyhmiw${ip
48	Wonpw	• Kvetlwerhefpiw • Errsxexnsrwsrkvetlw0$ships$erh$mekveqw • Hexe$rep}wwerhmrxitvixexnsr
49	Tvegxngi	• Tvegxngi$qeoiw$tivjigx • Viehliq evomrk$ymhipmriw$erhsy{mpors{ {lex$syxgsq iw$evi$evkixih

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Good luck!

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