Active Biology - student worksheets for VCE Biology Units 3 & 4 **contains the following worksheets (plus answer sheets):**

1.	The plasma membrane	28.	Types of specific immunity
2.	Movement across the plasma membrane	29.	The allergic response
3.	Exporting proteins from a cell	30.	Natural selection
4.	Nucleic acids	31.	Speciation
5.	DNA replication	32.	Changes in populations wordfind
6.	Proteins	33.	Variation in populations: polyploidy
7.	Protein synthesis	34.	Mutations
8.	Gene regulation	35.	Block mutations
9.	Alternative splicing	36.	Dating rocks
10.	Enzymes	37.	Fossils
11.	Enzymes wordfind	38.	Evidence for evolution
12.	Photosynthesis	39.	Determining relatedness between species
13.	Cellular respiration	40.	DNA-DNA hybridisation
14.	Anaerobic respiration	41.	Amino acid sequences: finding similarities
15.	Cellular signals	42.	Phylogenetic trees and the molecular clock
16.	Transduction of a hydrophilic signal	43.	Classifying humans
17.	Types of signalling molecules	44.	Evolution of hominins
18.	Apoptosis	45.	The path to becoming human
19.	Pathogens	46.	Changing lifestyles of modern humans
20.	Antigens	47.	DNA manipulation
21.	Innate immunity: first line of defence	48.	Gene editing using CRISPR-Cas9
22.	Innate immunity: second line of defence	49.	Predictive testing
23.	The inflammatory response	50.	DNA profiling
24.	Adaptive immunity: third line of defence	51.	Genetically modified organisms (GMOs)
25.	Humoral immunity flowchart	52.	Pandemic V Epidemic
26.	Cellular immunity flowchart	53.	The changing influenza virus
27.	Types of white blood cells	54.	Rational Drug Design

* Note that some of the above listed worksheets consist of two or more pages.

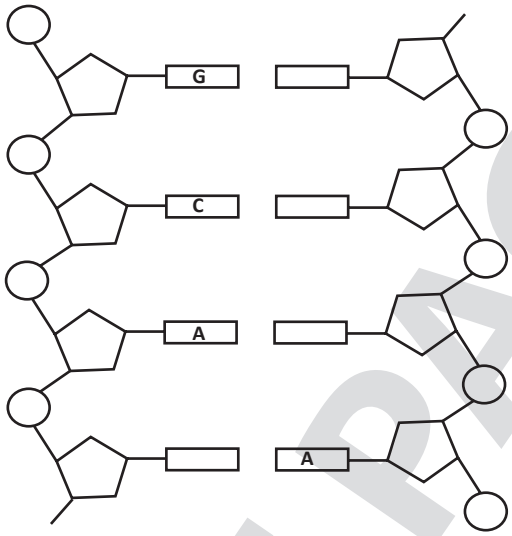
NUCLEIC ACIDS

1. DNA, or deoxyribonucleic acid, is a 'polymer'. What does this mean?

_____

_____

2. The following diagram shows part of a DNA molecule. It is unlabelled and not quite complete.



(a) Using two different colours, shade *and* label (i) the 'phosphate' part of each nucleotide (ii) the 'sugar' part of each nucleotide.

(b) Colour-code the four different types of nitrogen-containing bases and fill in any missing letters.

(c) Add hydrogen bonds (correct number) between each pair of complementary bases.

(d) Circle one complete nucleotide.

(e) For each chain, indicate the *5 prime* (5') and *3 prime* (3') end.

3. The two chains in a DNA molecule are said to run 'anti-parallel'. What does this mean?

_____

4. The two chains in a DNA molecule are actually arranged to form a double-helical structure, rather like a twisted rope ladder. In the space provided below, draw a simple diagram of a DNA double helix.

DNA double helix

(a) Which part of the double-stranded DNA molecule forms the 'rungs' of the ladder?

_____

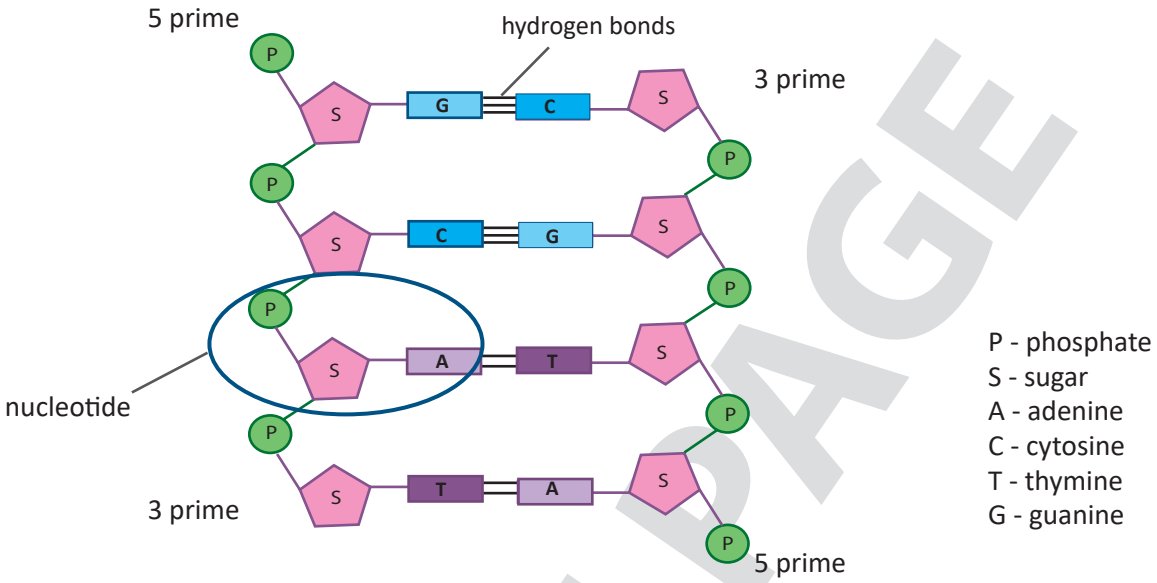
(b) Which part of the double-stranded DNA molecule forms the 'side rails' of the ladder?

_____

NUCLEIC ACIDS
(answers)

1. Being a *polymer* means that DNA is made up of similar sub-units called 'monomers'.

2.



(a) See above diagram.

(b) See above diagram.

(c) See above diagram.

(d) See above diagram.

(e) See above diagram.

3. The two chains running 'anti-parallel' means that they run in opposite directions; one chain runs from the *5 prime* to *3 prime* end, while the other runs from *3 prime* to *5 prime*.

4.

DNA double helix

(a) The nitrogen-containing bases form the 'rungs' of the ladder.

(b) The sugar-phosphate backbones form the 'side rails' of the ladder.

ALTERNATIVE SPLICING

1. What is meant by 'alternative splicing'?

_____

_____

2. What are the two ways in which alternative splicing can occur?

_____

MODELLING ALTERNATIVE SPLICING (activity)

MATERIALS: plasticine in four different colours, sharp pencil.

Part A

1. Cut 12 small rectangular pieces of plasticine in two different colours, with six pieces representing EXONS and six representing INTRONS

2. Number your introns and exons **1** - **6** by using the pencil to punch small holes into each piece.

3. Arrange all 12 pieces of plasticine to model a piece of pre-mRNA with 6 exons and 6 introns. This is your **base pre-mRNA** strand.

4. Use plasticine in two other colours to create a *cap* and a *poly-A tail.*

Part B

1. From your **base pre-mRNA** strand, remove all introns and then create four different, *complete* **mRNA** strands by:

    (a) removing exon 5
    (b) removing exons 2 and 6
    (c) removing exons 1, 2 and 4
    (d) removing exons 2, 3 and 5

2. Draw diagrams of your complete mRNA strands.

3. Use your **base pre-mRNA** strand to model INTRON RETENTION, where certain introns are retained rather than being cut out of the pre-mRNA. Create three different, *complete* mRNA strands of your own, removing some of the exons and retaining some of the introns. Draw diagrams of each of your mRNA strands.

The discovery of alternative splicing had profound implications in the science of genetics. How did it change what we believe about the way genes work?

_____

_____

_____

ALTERNATIVE SPLICING (answers)

1. Alternative splicing is a process in which genes are regulated so that they are able to produce more than one protein.

2. Exon juggling and intron retention.

MODELLING ALTERNATIVE SPLICING (activity)

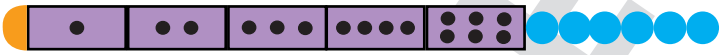
Part A

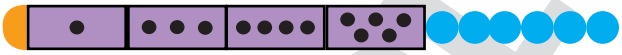
Base pre-mRNA strand (colours may vary):

 exon  intron

Cap:  Poly-A tail:  (shapes/colours may vary)

Part B

1. (a) 

(b) 

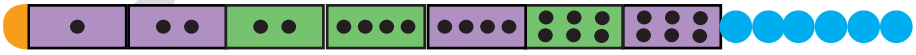
(c) 

(d) 

2. See diagrams 1 (a) - (d) above.

3. Student answers may vary. Examples of mRNA created as a result of intron retention could include:

(i) 
(remove exons 2, 4, 5 & introns 1, 4 - 6)

(ii) 
(remove exons 3, 5 & introns 1, 3 and 5)

(iii) 
(remove exons 1, 5 and 6 & introns 1, 3 and 5)

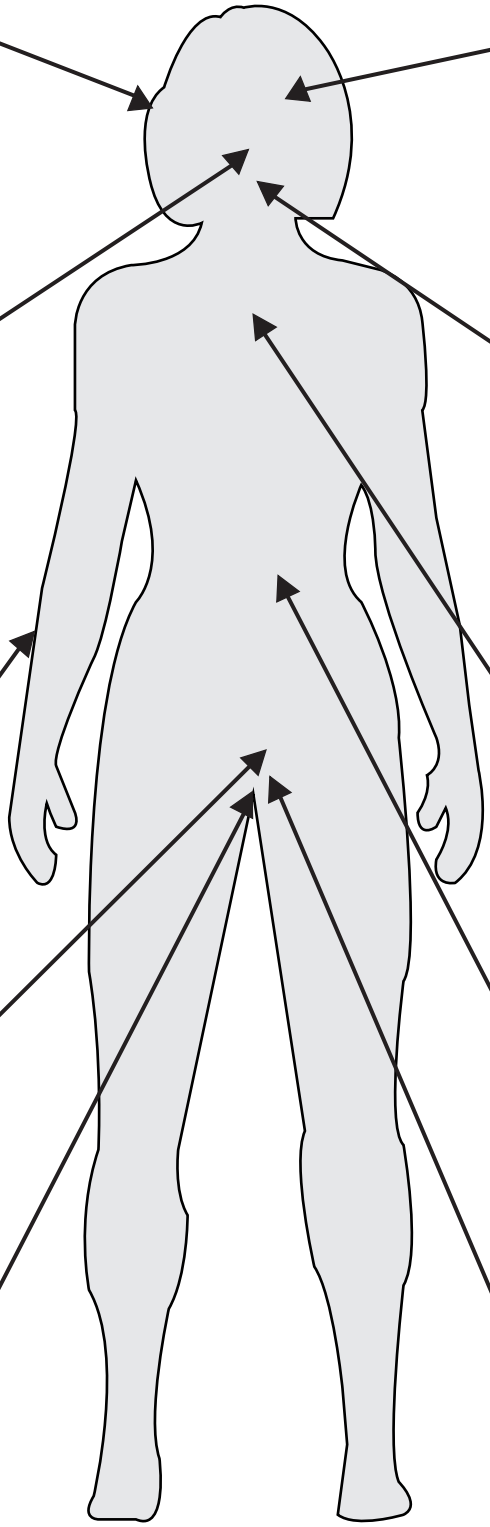
Previously, it was believed that genes produced only one protein each, that is, the 'one gene, one polypeptide concept'. The discovery of alternative splicing changed this thinking, as it became apparent that some genes are able to produce a variety of protein products. Alternative splicing also helps to explain why a relatively small number of genes (approximately 21,000) can account for the total number of different proteins that the human body can make, which scientists estimate could be as many as 2 million.

INNATE IMMUNITY: FIRST LINE OF DEFENCE

Describe the ways in which each body area provides protection from pathogens in the first line of defence:

EARS

EYES



NASAL CAVITY

MOUTH CAVITY

SKIN

AIRWAYS

URETHRA

STOMACH

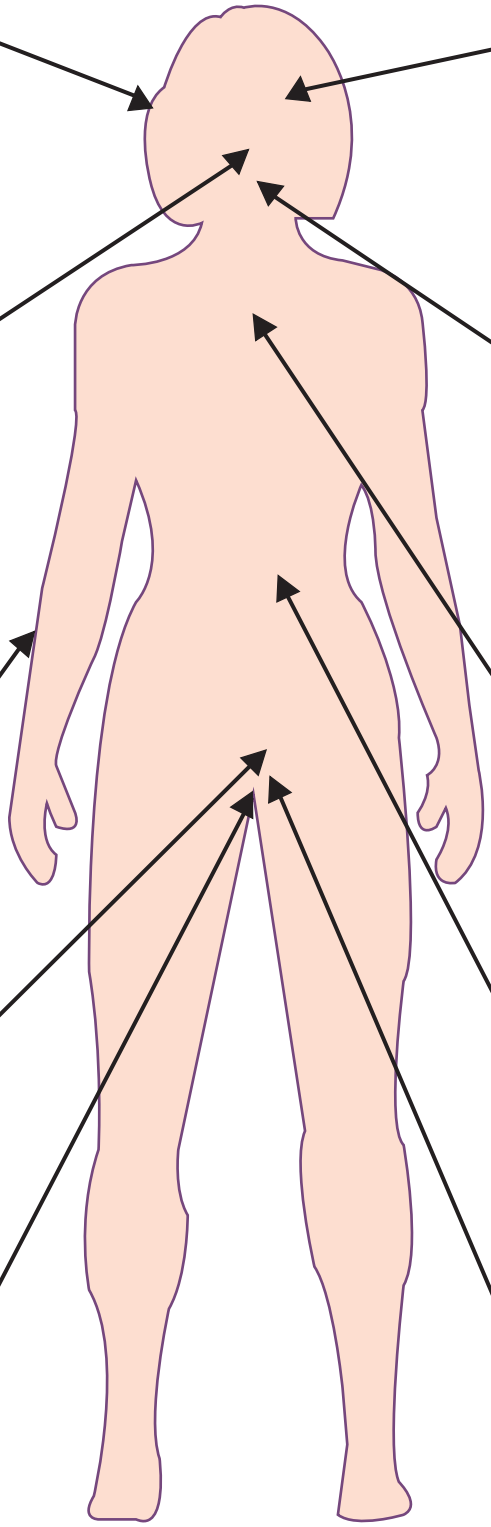
GENITAL TRACT

ANUS

INNATE IMMUNITY: FIRST LINE OF DEFENCE
(answers)

EARS
* Produce cerumen (earwax) that helps to inhibit growth of bacteria.

EYES
* Produce tears which clean the eyes and contain lysozome, an enzyme that lyses bacteria.



NASAL CAVITY
* Contains hairs and mucus that trap microorganisms.

MOUTH CAVITY
* Produces saliva, which also contains lysozyme enzyme that lyses bacteria.
* Contains natural flora, harmless bacteria that can inhibit the growth of pathogenic bacteria.

SKIN
* Provides an impenetrable barrier against pathogens.
* Sebaceous glands secrete *sebum*, which contains fatty acids that have anti-bacterial properties.
* Produces sweat, which contains an anti-microbial protein called *dermcidin.*

AIRWAYS
* Have a layer of mucus that traps microorganisms.
* Hair-like structures called *cilia* help move mucus and the bacteria it contains to the back of the throat. Here, the mucus is either expelled by coughing, or swallowed.

URETHRA
* Flow of urine regularly cleanses surfaces, which can help prevent pathogens from becoming established.

STOMACH
* Produces strong stomach acid that kills bacteria.

GENITAL TRACT
* Contains natural flora that inhibits growth of pathogenic bacteria.

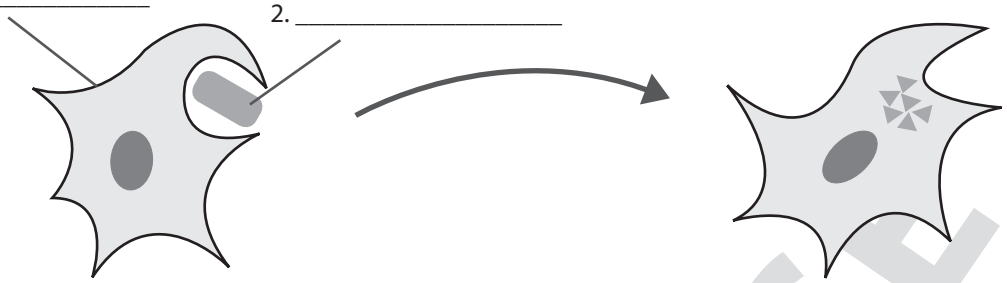
ANUS
* Has mucous membranes that trap microorganisms.

HUMORAL IMMUNITY FLOWCHART

Complete the following flowchart by labelling the various cells/structures and providing brief captions:

1. _____

2. _____



_____

_____

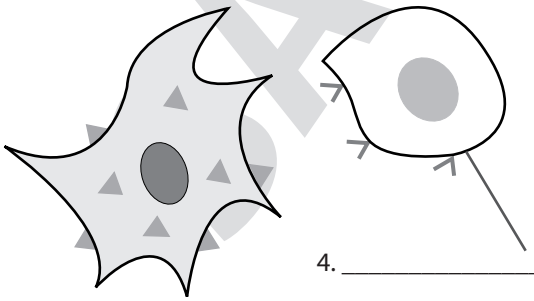
_____

_____

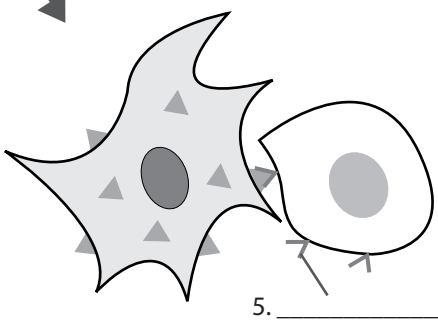
3. _____

_____

_____



4. _____



5. _____

_____

_____

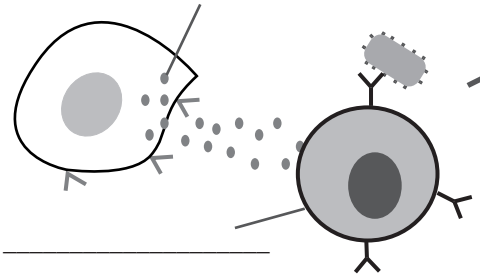
_____

_____

HUMORAL IMMUNITY FLOWCHART

(Cont.)

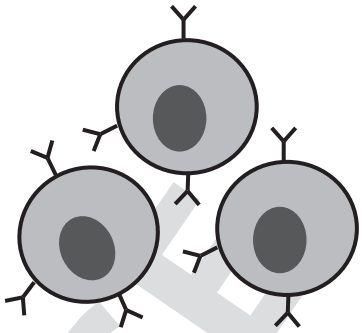
6. _____



7. _____

_____

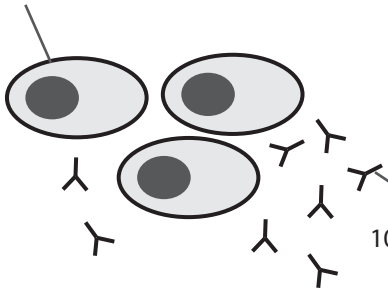
_____



_____

_____

8. _____

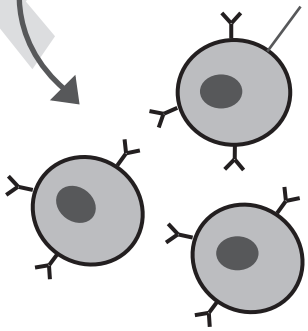


10. _____

_____

_____

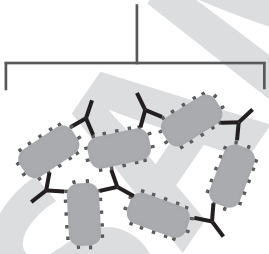
9. _____



_____

_____

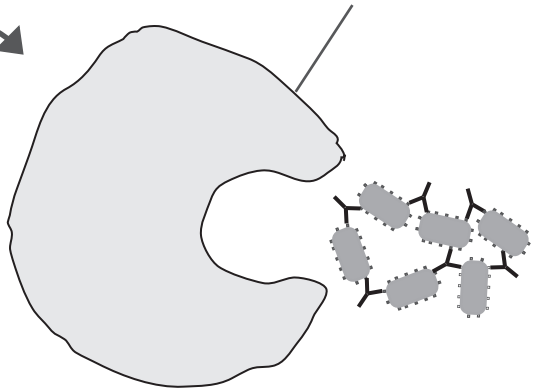
11. _____



_____

_____

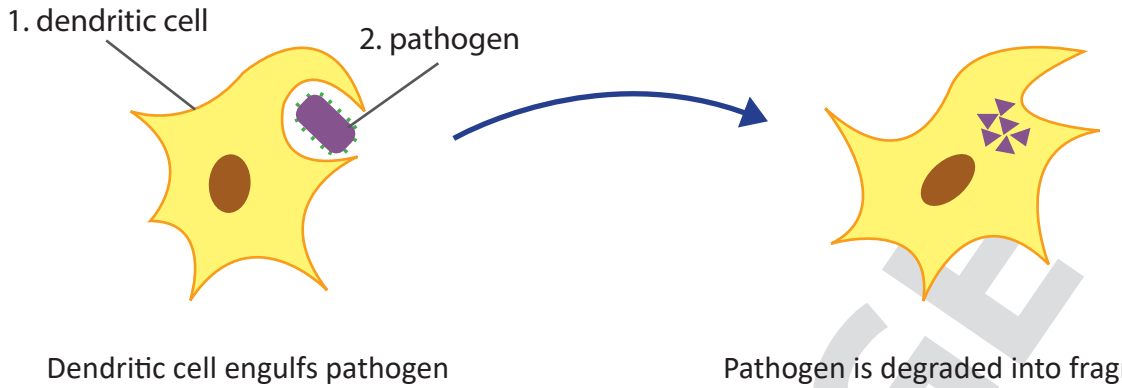
12. _____



_____

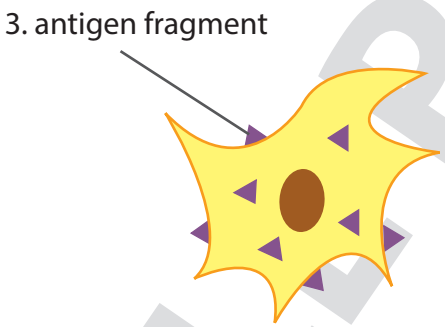
_____

HUMORAL IMMUNITY FLOWCHART (answers)

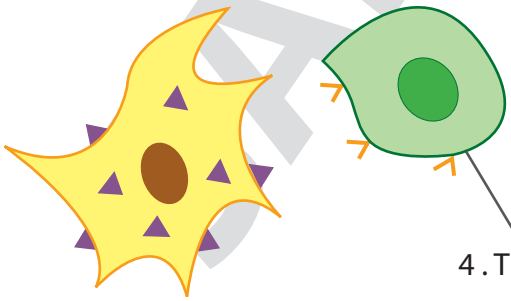


Dendritic cell engulfs pathogen

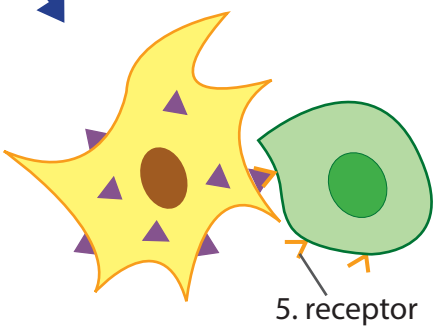
Pathogen is degraded into fragments



Some fragments are transferred to the surface of the dendritic cell



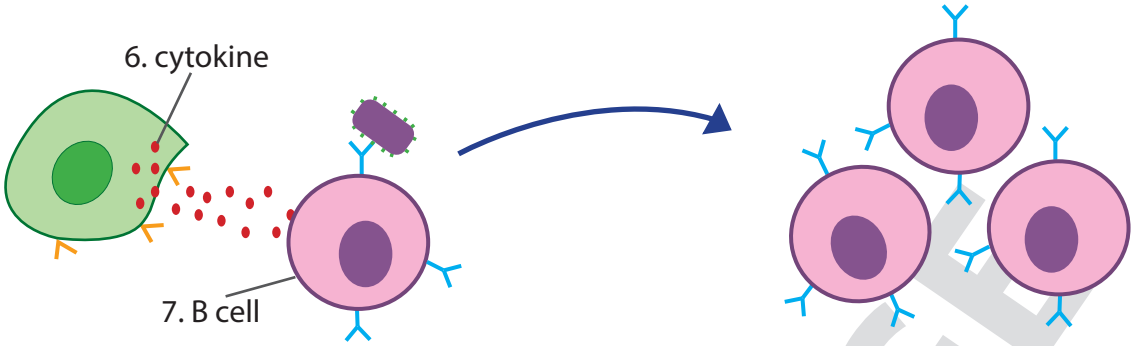
Dendritic cell presents antigen fragments to T helper cell



T helper cell binds to the antigen via receptors on its surface; this activates the helper cell

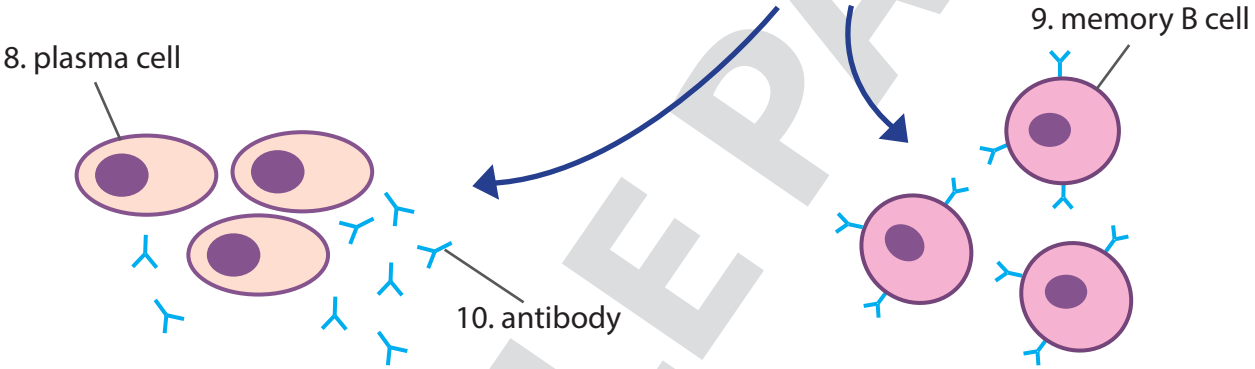
HUMORAL IMMUNITY FLOWCHART (answers)

(Cont.)



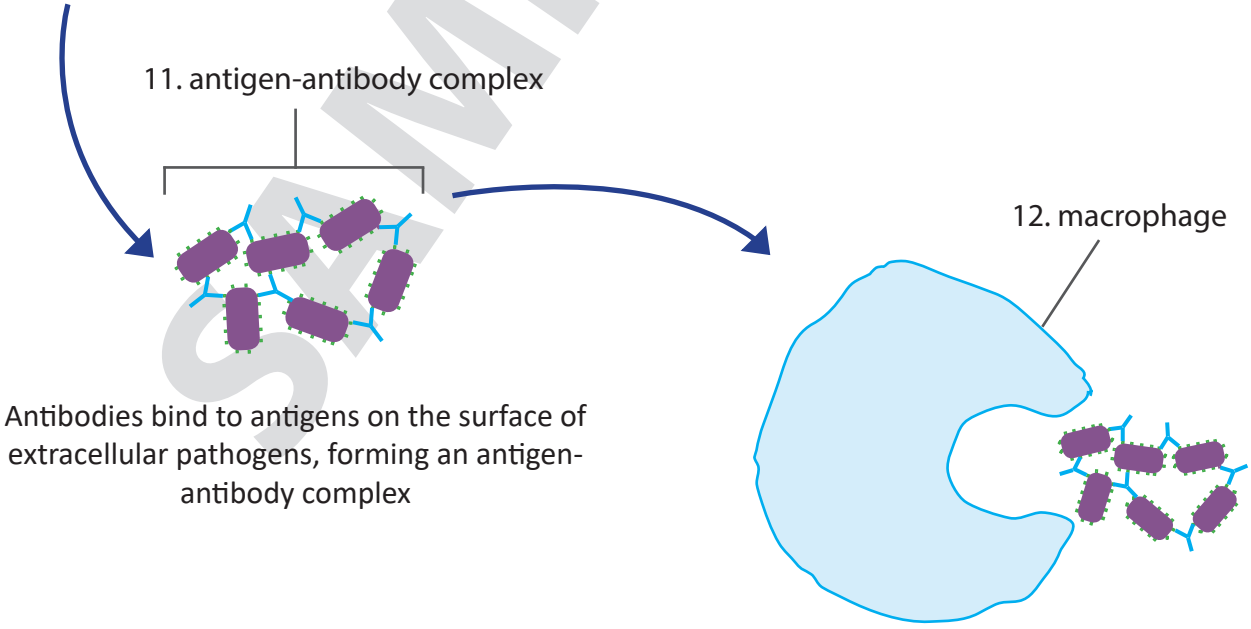
T helper cell releases cytokines that activate B cell

B cell undergoes clonal expansion to produce a clone of B cells



Most of the cloned B cells differentiate into antibody-producing plasma cells

Some of the cloned B cells differentiate into memory B cells



Antibodies bind to antigens on the surface of extracellular pathogens, forming an antigen-antibody complex

Macrophage engulfs and destroys antigen-antibody complex by phagocytosis

THE ALLERGIC RESPONSE

Fill in the gaps in the flowchart using words from the list provided (words can be used more than once):

Person makes contact with potential _____

The immune system identifies the _____ as _____

and activates an _____ response

_____ _____ against the allergen are produced

_____ _____ bind to surface _____

on nearby _____ cells

Person becomes _____ to the allergen

A _____ exposure to the allergen causes _____

antibodies on _____ cells to recognise and bind to the _____

_____ cells are activated and start to release _____

Release of _____ results in increased _____ flow to the area

as well as increased _____ of blood vessels,

causing redness, _____ and pain.

Mast cells produce _____ messengers that _____

other immune cells to the affected tissue

Influx of immune cells results in even more chemicals being released,

increasing the _____ and causing tissue _____

Word list:

sensitised - **inflammation** - **immune** - **permeability** - **second** - **chemical** - **allergen** - **antibodies** - **damage** - **receptors** - **IgE** - **swelling** - **mast** - **attract** - **histamine** - **non-self** - **blood**

THE ALLERGIC RESPONSE
(answers)

Person makes contact with potential **allergen**

The immune system identifies the **allergen** as **non-self** and activates an **immune** response

IgE antibodies against the allergen are produced

IgE antibodies bind to surface **receptors** on nearby **mast** cells

Person becomes **sensitised** to the allergen

A **second** exposure to the allergen causes **IgE** antibodies on **mast** cells to recognise and bind to the **allergen**

Mast cells are activated and start to release **histamine**

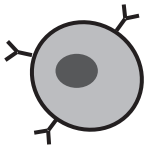
Release of **histamine** results in increased **blood** flow to the area as well as increased **permeability** of blood vessels, causing redness, **swelling** and pain.

Mast cells produce **chemical** messengers that **attract** other immune cells to the affected tissue

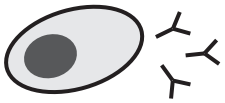
Influx of immune cells results in even more chemicals being released, increasing the **inflammation** and causing tissue **damage**

Word list:

sensitised - **inflammation** - **immune** - **permeability** - **second** - **chemical** - **allergen** - **antibodies** - **damage** - **receptors** - **IgE** - **swelling** - **mast** - **attract** - **histamine** - **non-self** - **blood**



TYPES OF WHITE BLOOD CELLS



Using a system of colour-coding, match the name of the cells to their correct function:

B lymphocytes

Release histamines during inflammation

Plasma cells

Memory B cells

Destroy intracellular pathogens in 3rd line of defence

Main antigen-presenting cells

T helper cells

Can 'remember' an antigen; involved in cellular immunity

Monocytes

NK cells

Basophils

Release histamines during the allergic response

Suppressor T cells

Differentiate into plasma cells

Neutrophils

Produce cytokines that stimulate B and T cells

Dendritic cells

Mast cells

Differentiate into macrophages

Can 'remember' an antigen; involved in humoral immunity

Memory T cells

Eliminate pathogens by degranulation

Produce antibodies

Cytotoxic T cells

Type of phagocytes involved in 2nd line of defence

Limit or stop an immune response

TYPES OF WHITE BLOOD CELLS
(answers)

B lymphocytes

Release histamines during inflammation

Plasma cells

Memory B cells

Destroy intracellular pathogens in 3rd line of defence

Main antigen-presenting cells

T helper cells

Can 'remember' an antigen; involved in cellular immunity

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Eliminate pathogens by degranulation

Produce antibodies

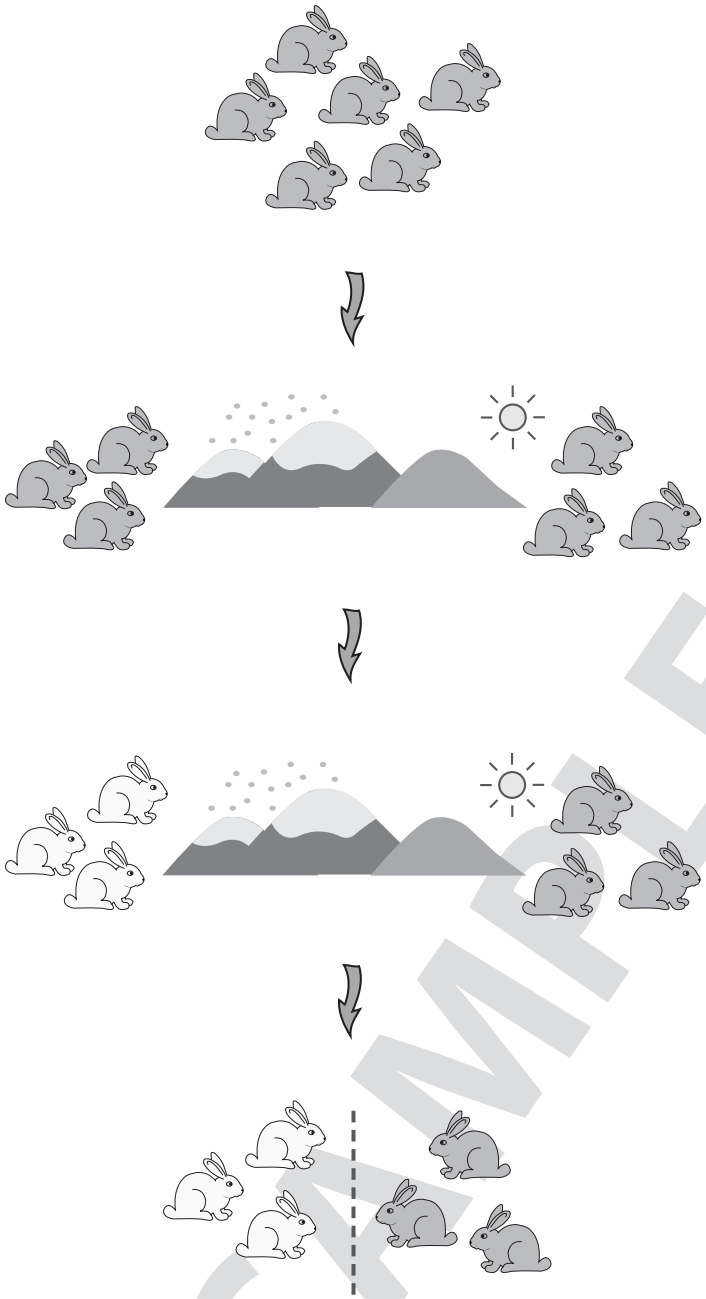
Cytotoxic T cells

Type of phagocytes involved in 2nd line of defence

Limit or stop an immune response

SPECIATION

1. The following flow diagram shows *speciation*, the process of formation of new species. In the spaces provided, write captions to explain, in scientific terms, what is happening at each step.



2. What type of speciation is that which occurs as the result of two populations becoming geographically isolated from one another?

_____

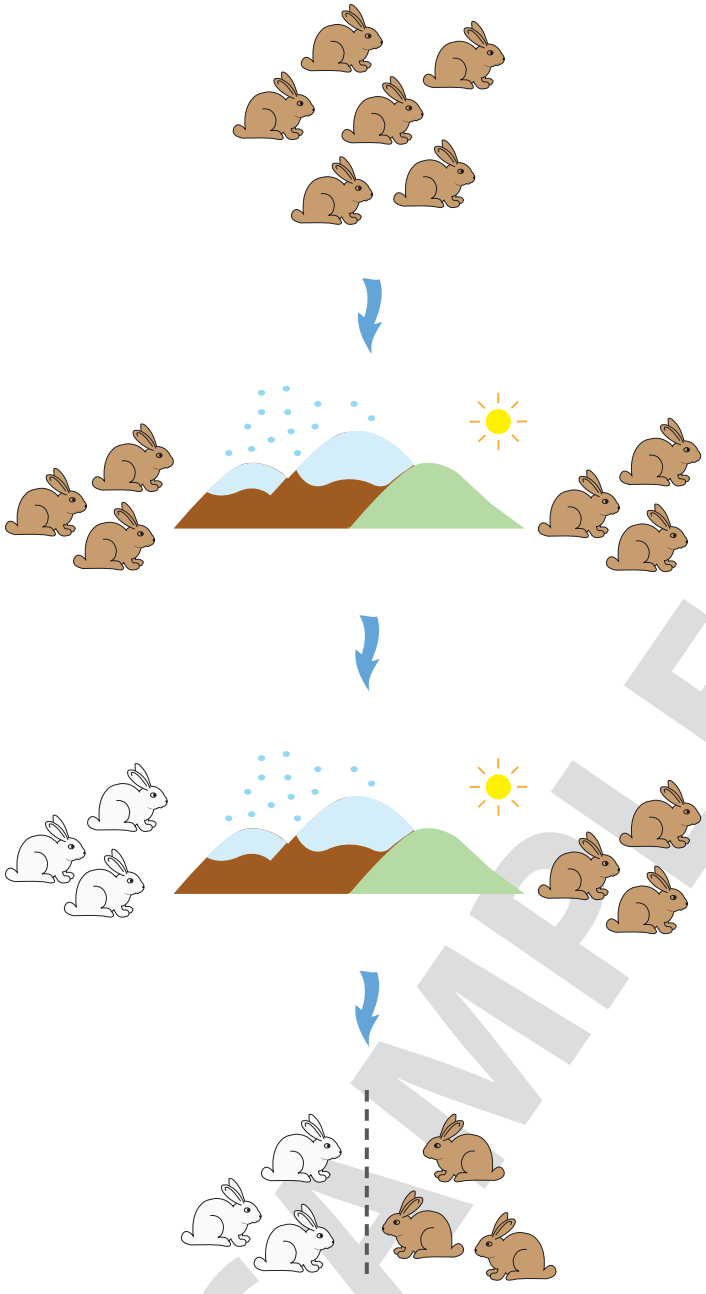
3. If two different populations are considered to be *subspecies*, what does this mean?

_____

_____

SPECIATION
(answers)

1.



In the beginning there is one rabbit population, with all its members belonging to the same species.

Two populations of the rabbit species become geographically isolated by a mountain range (formed by uplift in extremely slow geological processes).

The isolated populations are subjected to different selection pressures because of the differences in environmental conditions. They start to become less and less alike, evolving in different directions.

If the two rabbit populations are later brought back together they can no longer interbreed; they have become two different species.

2. Allopatric speciation

3. If two populations are considered subspecies, this means that while they might look quite different to each other, they are still capable of interbreeding and producing healthy, fertile offspring. They therefore still belong to the same species.

VARIATION IN POPULATIONS: POLYPLOIDY

1. 'Polyploidy' is a condition that is rare in animals, but not unusual in plants. What is polyploidy?

_____

2. Define the following:

(a) Tetraploid: _____

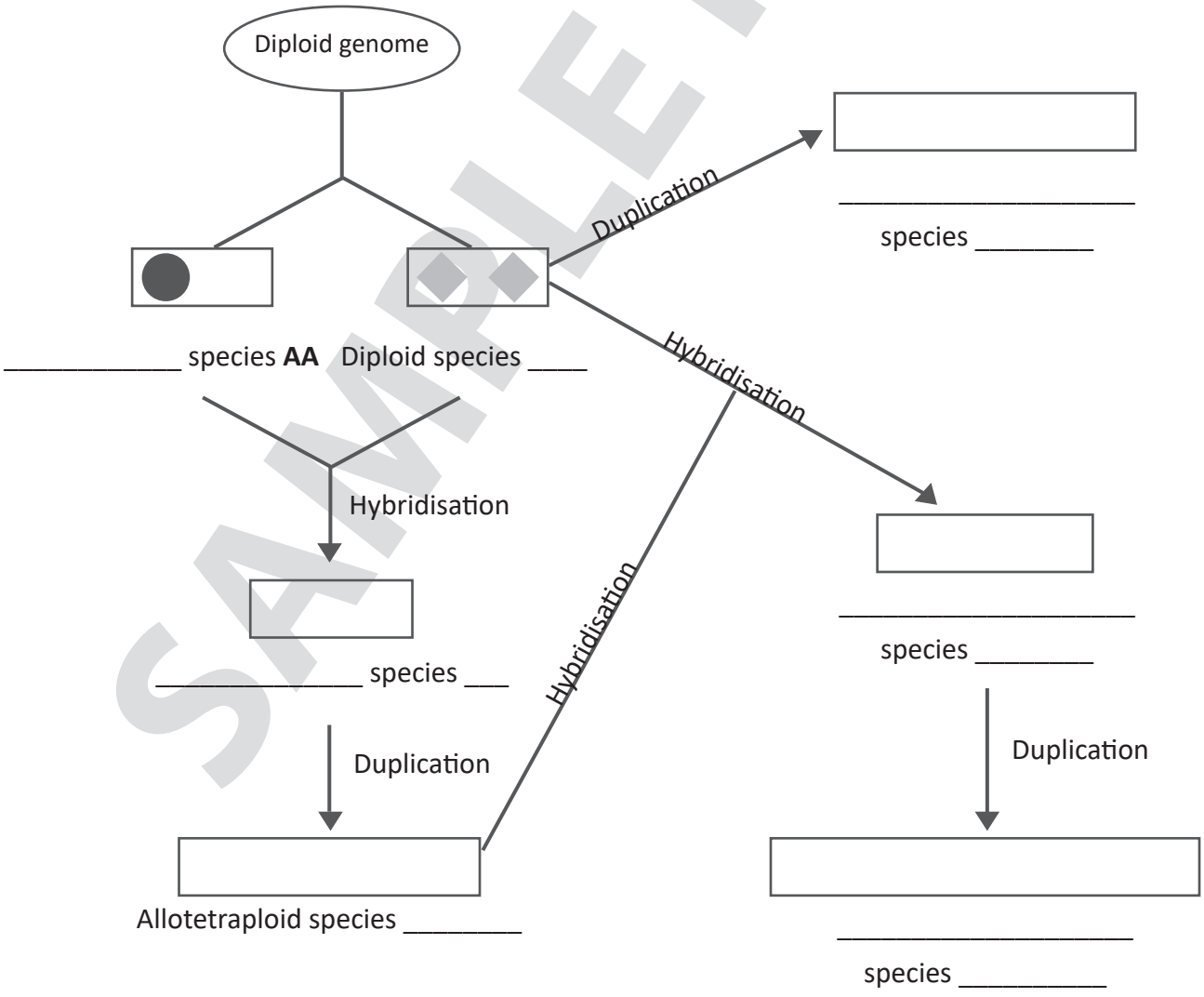
(b) Hexaploid: _____

(c) Autopolyploid: _____

(d) Allopolyploid: _____

3. It is possible to create polyploid plants by (i) *hybridisation*: crossing two parents from different species and (ii) *duplication*: doubling the number of chromosomes by using chemical treatment.

Complete the following diagram showing how polyploid plants can be created using two species, **A** and **B**.



haploid chromosome set for species **A**

haploid chromosome set for species **B**

VARIATION IN POPULATIONS: POLYPLOIDY
(answers)

1. Polyploidy is a condition in which an organism has more that two matching sets of chromosomes.

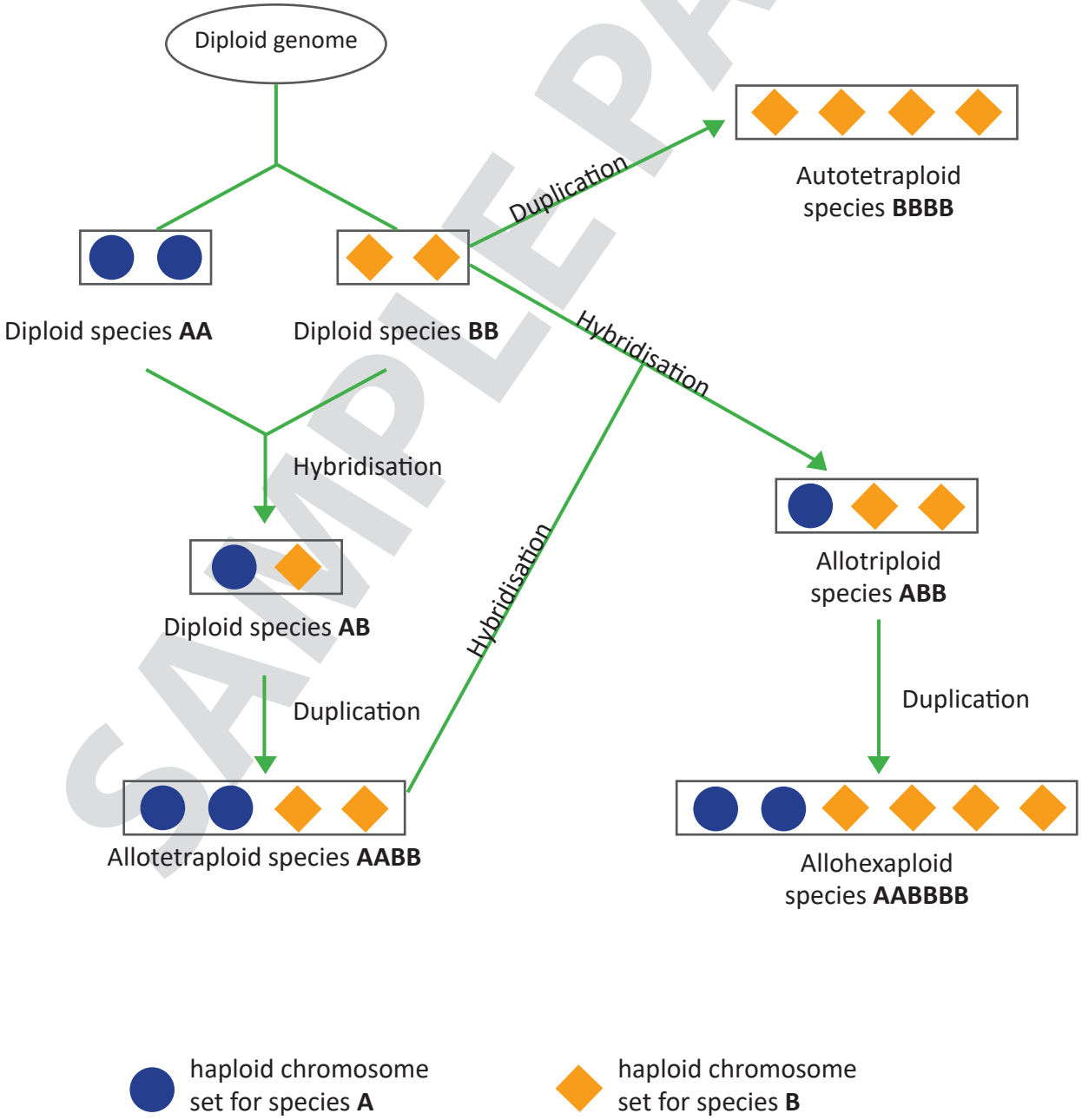
2. (a) Tetraploid: describes an organism that has four sets of chromosomes.

   (b) Hexaploid: describes an organism that has six sets of chromosomes.

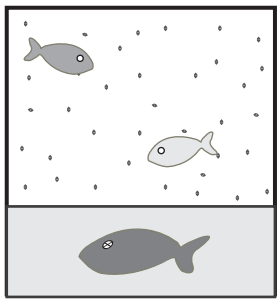
   (c) Autopolyploid: describes an organism that has extra sets of chromosomes from its own species.

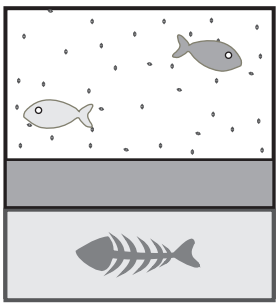
   (d) Allopolyploid: describes an organism that has extra sets of chromosomes from a different species.

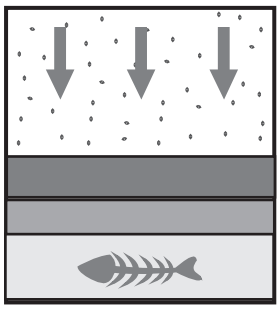
3.

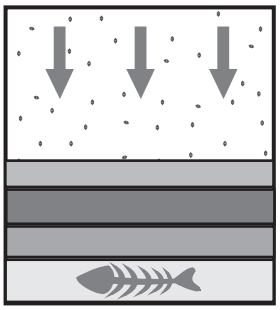


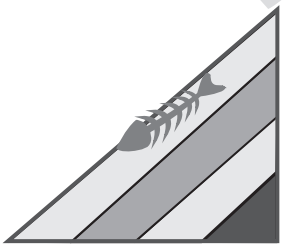
Processes involved in the fossilisation of a fish.



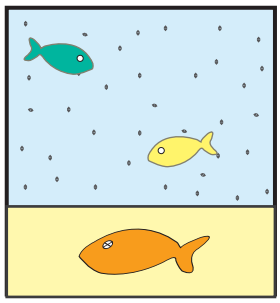




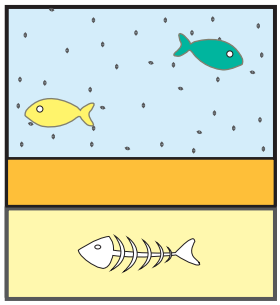




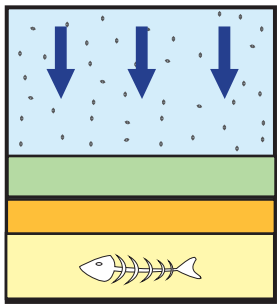
Processes involved in the fossilisation of a fish.



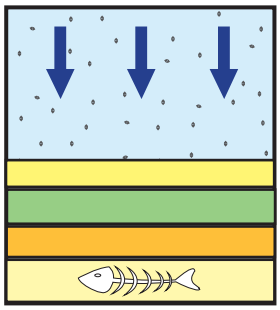
Fish dies and is quickly buried by sand at the bottom of the sea, protecting it from being eaten by other animals.



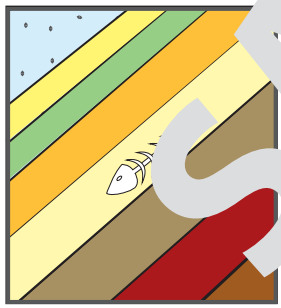
Over time, more sediment is deposited on the seafloor, forming a new layer. Softer parts of the animal decay, leaving the hard skeleton.



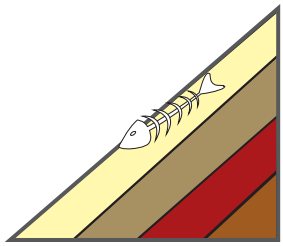
As more layers of sediment are deposited, the added weight puts great pressure on the original layer containing the dead fish. Layers of sediment are squeezed together.



New layers of sediment continue to form, increasing the pressure on the deeper layers. This pressure causes the sediments to become compressed and eventually turn into rock.



After millions of years, the sedimentary rock layers may be thrust upwards by great geological forces, and become part of a mountain range.



Processes such as weathering and erosion may eventually wear away the top layers of rock, exposing the fossil fish.

THE CHANGING INFLUENZA VIRUS

1. What are the three types of influenza virus?

   _____

2. What is meant by the *strain* of an influenza virus?

   _____

3. What two proteins on the surface of an influenza virus determine its *subtype*?

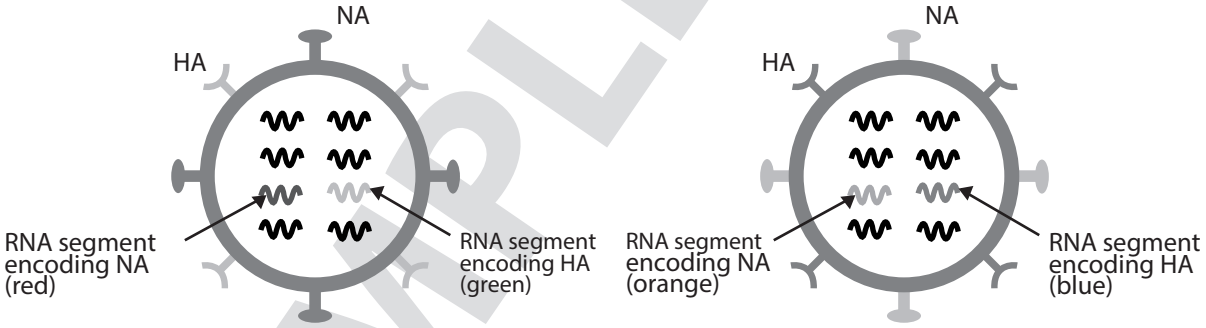
   _____

4. A strain from a type of avian flu virus was designated as **A/duck/Alberta/35/76/(H1N1)**. What does this information mean?

   _____

   _____

5. The following diagram shows two strains of the influenza virus, (a) **H5N1** and (b) **H3N2**. The viral surface proteins, **HA** and **NA** are also shown, as well as the 8 RNA segments found in the core of each virus.



(a) Virus **H5N1** (b) Virus **H3N2**

If a person becomes infected with both of these viruses at the same time, it is possible for a re-assortment of genetic material to occur, creating a new strain, **H5N2**.

(a) Complete diagram (c) on the right by showing what the core *and* surface proteins of the new virus strain **H5N2** would look like, using the colours assigned in diagrams (a) and (b) above.

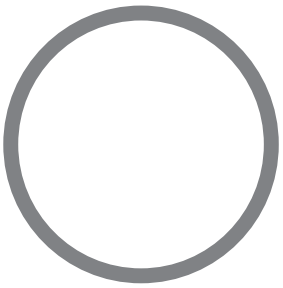
(b) This type of change can be described as an *antigenic shift*. What does this mean?

   _____

   _____

   _____

   _____



(c) Virus **H5N2**

THE CHANGING INFLUENZA VIRUS
(answers)

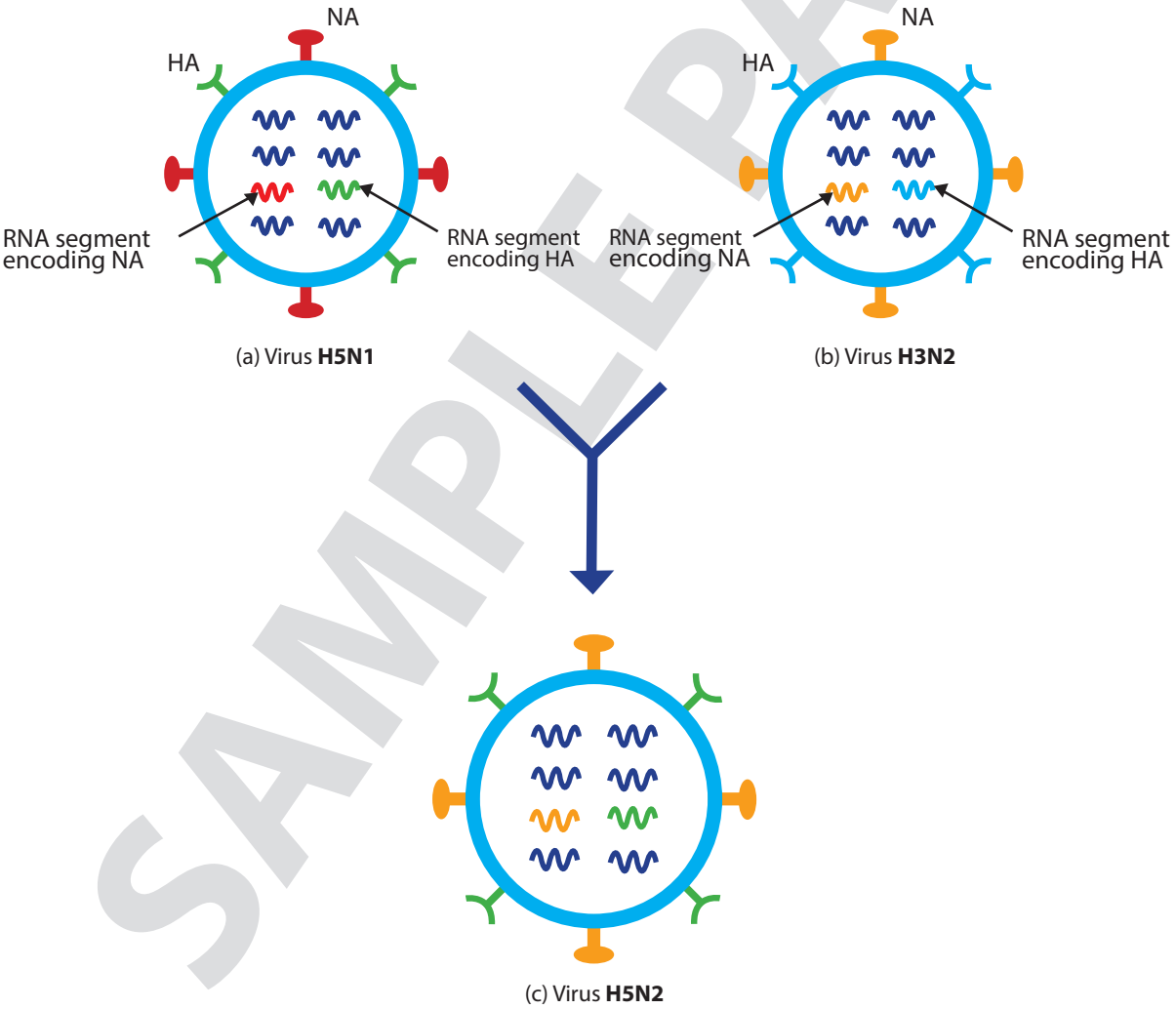
1. Type **A**, type **B** and type **C**.

2. The *strain* of an influenza virus is the genetic variant or particular biological form of the virus.

3. Hemagglutinin (HA) and neuraminidase (NA).

4. **A/duck/Alberta/35/76/(H1N1)** indicates a type **A** virus that was first discovered in a **duck**, originated in **Alberta** (Canada), is strain number **35** and was isolated in the year 19**76**. Its subtype is **H1N1**.

5.



(a) See above diagram.

(b) This type of change is described as an 'antigenic shift' because there has been a sudden, major change in the virus' *antigenic properties*, that is, the extent to which it is able to alter its surface proteins in order to evade the host's immune system (this is different to *antigenic drift*, which involves only small mutations that are usually still recognised by the immune system).