Student Number……

PENRITH SELECTIVE HIGH SCHOOL 2024

TRIAL EXAMINATION

HSC BIOLOGY

General Instructions:

- Reading time – 5 minutes
- Exam time – 3 hrs
- Board-approved calculators may be used
- Write using **blue or black** pen
- Graphs should be completed in pencil
- All other answers written in pencil may be disqualified from review

PART A – Multiple Choice (20)

* Attempt Questions 1-20
* Allow about 30 minutes for this section
* Use the multiple-choice answer sheet found at the end of this paper to answer questions 1-20

PART B – FREE RESPONSE QUESTIONS

* Attempt Questions 21 - 31
* Allow about 2 hours 30 minutes for this section

TOTAL MARKS:

/100

PART A – MULTIPLE CHOICE QUESTIONS

Attempt Questions 1-20

Allow approximately 30 minutes for this section

Use the multiple-choice answer sheet for questions 1-20

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1) In mice, brown fur is dominant over white fur. If a heterozygous brown mouse is mated several times with a white mouse and 80 offspring are produced, how many would theoretically be expected to have white fur (assuming genotypic ratios are followed exactly)?
   A) 80
   B) 40
   C) 0
   D) 20

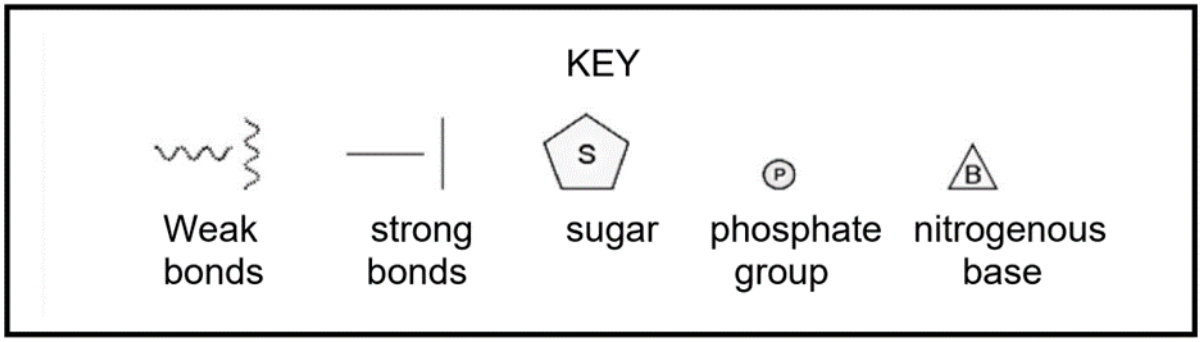
2) The table below shows information about types of pathogens.

Pathogen Type	Example	Living/Non-living	Example of disease
B	Misfolded PRNP proteins	Non-living	CJD
Virus	HIV	**A**	AIDS
Bacteria	*Vibrio cholerae*	Living	Cholera
Fungus	*Candida albicans*	Living	Thrush
Prokaryote	*Entamoeba histolytica*	Living	Amoebic dysentery
Macroparasite	*Schistosoma haematobium*	Living	Schistosomiasis

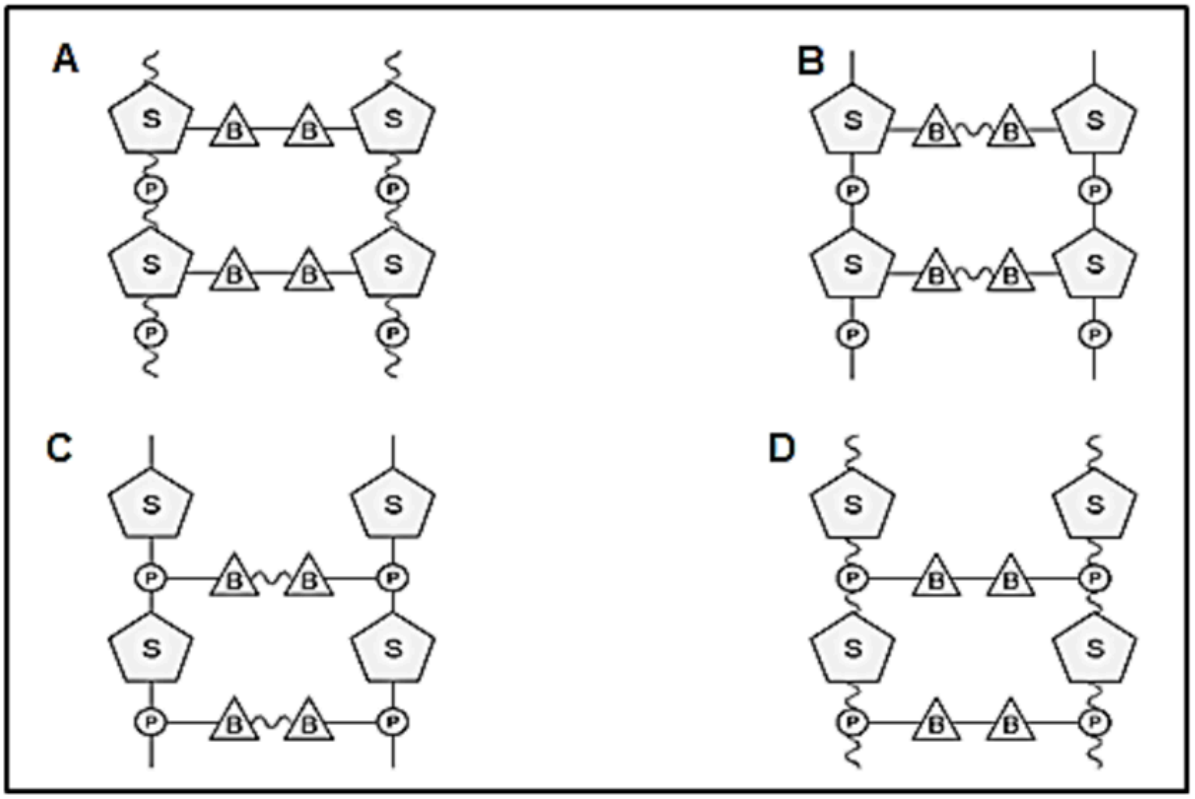
A and **B** in the table refer to which of the following;

   A) Living and miasma
   B) Living and prion
   C) Non-living and prion
   D) Non-living and archaean

3) The key below shows the main components of a DNA molecule and the strength of the bonds that hold them together.



Which ONE of the following diagrams shows the correct combination of components of a DNA molecule?

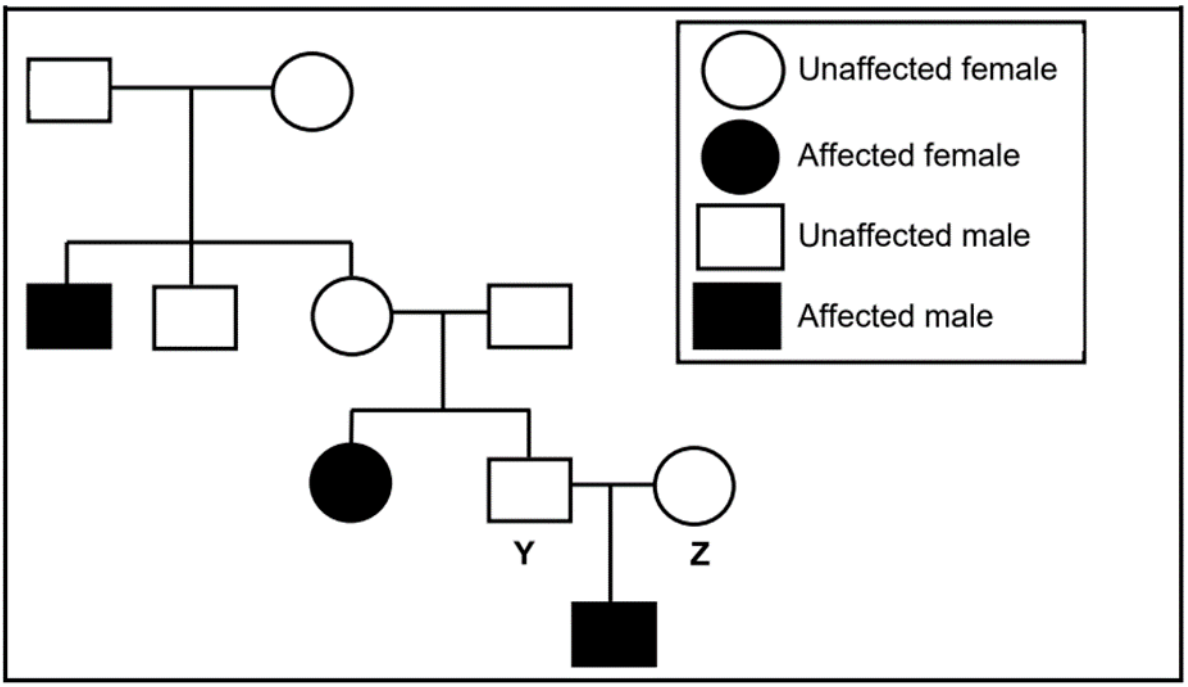


A) A
B) B
C) C
D) D

4) H5N1 Avian Influenza (bird flu) is a common disease of poultry around the world. It spreads from wild birds, particularly ducks, geese and swans, to chickens in farms. Australia is currently attempting to prevent outbreaks of this disease spreading widely from infected farms. Strategies to prevent the spread of this disease include;

A) Vaccinating all wild birds in Australia
B) Humanely euthanizing (killing) infected flocks
C) Spraying passengers on incoming international flights with pesticide
D) Providing antiviral medication to all infected chickens

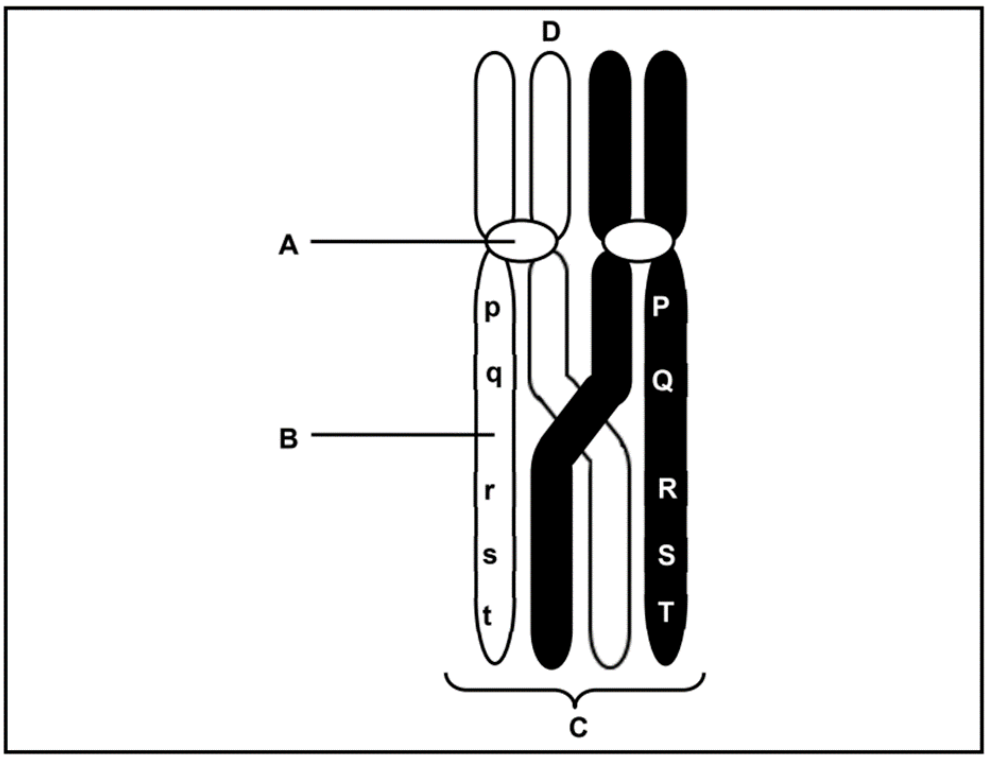
5) Albinism is a skin disorder caused by a recessive allele on an autosome. The pedigree diagram below represents the inheritance of albinism in a family.



The probability of individuals Y and Z having another child with albinism is

A) 25%
B) 50%
C) 75%
D) 100%

6) The diagram below shows the process of crossing over.



During which stage of Meiosis does crossing over occur?

A) Meiosis 1 Metaphase
B) Meiosis 2 Metaphase
C) Meiosis 1 Prophase
D) Meiosis 2 Prophase

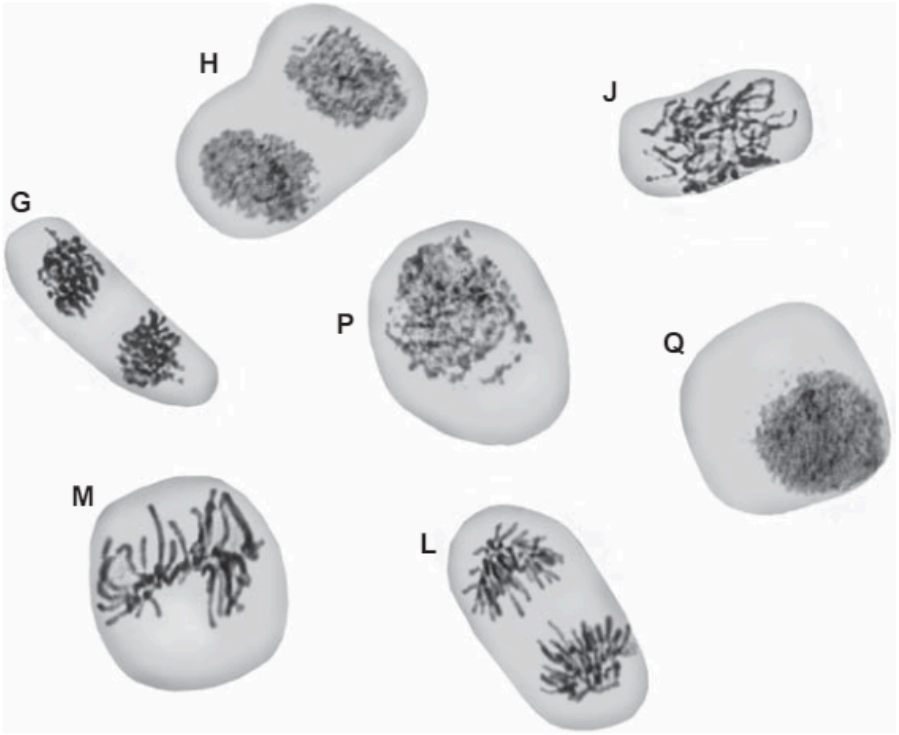
7) An example of homeostasis is when

A) root hairs of a pumpkin plant grow towards a source of water.
B) evaporation of water from the body surface after swimming has a cooling effect.
C) cabbage plants grown in a phosphorus-deficient soil mobilise phosphorus from tissues and release it into the phloem.
D) the body surface colour of the chameleon lizard changes to match the colour of the foliage on which it is resting.

8) Recognition and protection of indigenous cultural and intellectual property is important because

A) it preserves cultural heritage and fulfils legal and ethical obligations.
B) it encourages the exploitation of natural resources for financial gain.
C) it allows businesses to avoid costs involved in research and development.
D) it leads to assimilation of indigenous cultures into the mainstream of Australian life.

9) The following images show plant cells from a tissue that is undergoing mitosis.



The order of the cells in a single mitotic phase would be

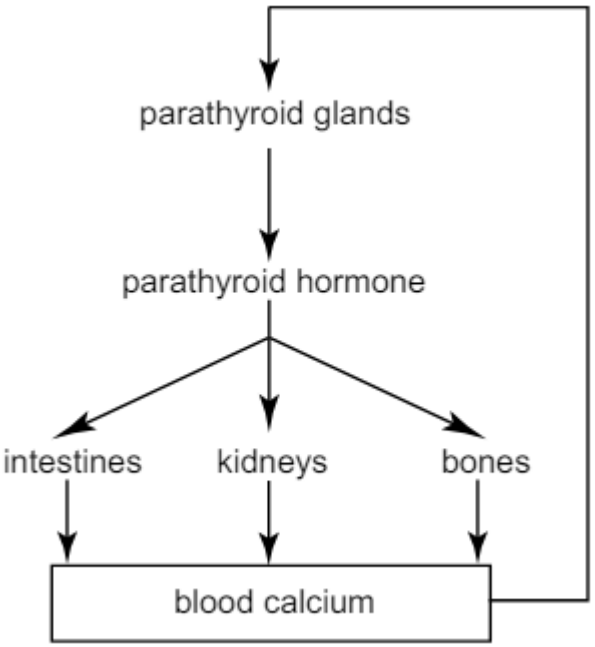
A) Q P J M L G H.
B) P Q M G J L H.
C) P G L M J Q H.
D) Q H J P L G M.

10) Onchocerciasis, commonly known as “river blindness”, is caused by the parasitic worm *Onchocerca volvulus*. It is transmitted to humans through exposure to repeated bites of infected blackflies of the genus Simulium. Symptoms include severe itching, disfiguring skin conditions, and visual impairment, including permanent blindness.

Which of the following is true for onchocerciasis?

A) Both *Onchocerca volvulus* and blackflies are vectors.
B) Both *Onchocerca volvulus* and blackflies are pathogens.
C) Blackflies are the vectors and *Onchocerca volvulus* is the pathogen.
D) Blackflies are the pathogens and *Onchocerca volvulus* is the vector.

11) The following flow chart shows a feedback mechanism related to parathyroid hormone. Parathyroid hormone acts on various parts of the body and stimulates an increase in the concentration of blood calcium.

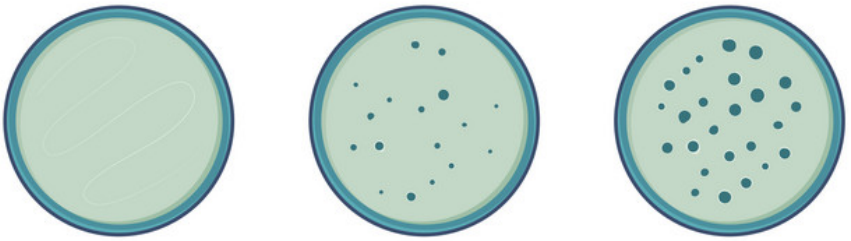


At any fall in the level of calcium in the blood, action by the parathyroid hormone would result in

A) a rise in the level of calcium in urine.
B) an increase in absorption of calcium by bones.
C) a reduction in the activity of the parathyroid glands.
D) increased absorption of calcium from the intestines.

Questions 12 and 13 refer to the information below.

The image below shows the result of an experiment to determine the number of bacteria in three different water samples. The samples were collected from water sources in a village. All of the samples were incubated at 37°C for one week.



12) What is the independent variable in this investigation?

A) The number of colonies
B) The number of individual bacteria
C) The type of nutrient agar used
D) The water source

13) One limitation of the experimental design used above is;

A) The reliability of the experiment cannot be determined because only one sample has been tested from each location
B) The experiment is unreliable because there is no repetition
C) The results are not accurate because you cannot count all of the microscopic bacterial cells
D) The results are not reliable because we do not know the time of day the samples were collected

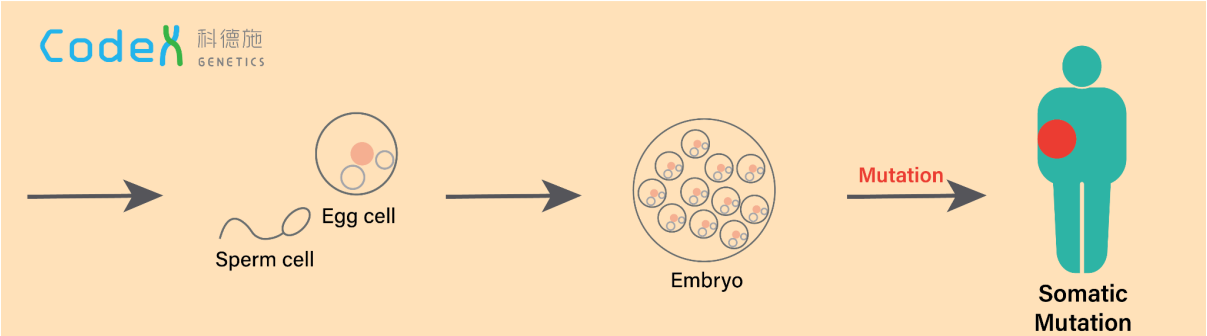
14) The table shows the incidence of infectious, respiratory diseases in a Sydney High School.

Disease	Number of cases per 100 students per year
Common cold	63
Influenza	12
COVID 19	28
RSV	4

Which type of graph should be chosen to best represent these data?

A) A column graph because incidences are continuous.
B) A line graph because diseases are categorical.
C) A column graph because diseases are categorical.
D) A line graph because incidences are continuous.

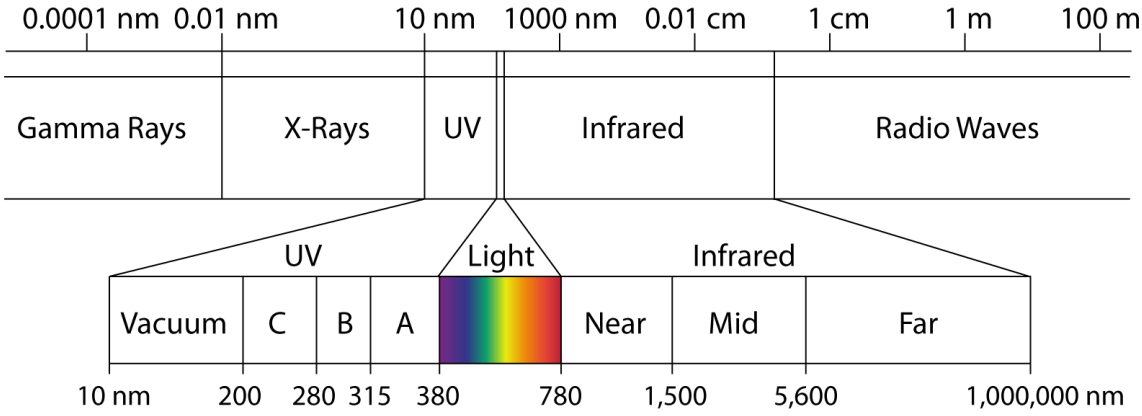
15) Somatic mutations will…



Source: https://www.codexgenetics.com/blog/en/Somatic-Mutation-and-Germline-Mutation-in-Cancer/

A) affect that cell and any others produced by mitosis, but will not be passed onto offspring.
B) affect all gametes produced by the person.
C) affect only that cell but not any others produced by mitosis.
D) affect that cell and any others produced by mitosis, but will be passed onto offspring.

16) The electromagnetic spectrum below provides a visual depiction of a range of electromagnetic radiation. The spectrum is divided into separate bands, with different names for the electromagnetic waves within each band.



Source: https://www.armstrongeconomics.com/armstrongeconomics101/understanding-cycles/the-schema-frequency/

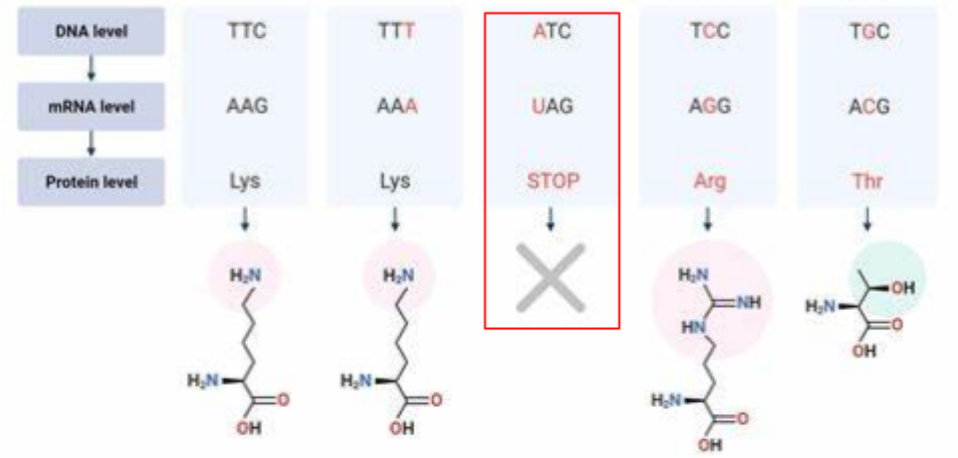
Why do gamma rays cause more biological harm than infrared waves?

A) Gamma rays have longer wavelengths, allowing them to penetrate and heat biological tissues more effectively than infrared waves.
B) Gamma rays have shorter wavelengths and higher energy, which enables them to ionize atoms and molecules, causing DNA damage and cell death.
C) Gamma rays interact with the outer layers of the skin, causing superficial burns, while infrared waves penetrate deeper without causing significant harm.
D) Gamma rays primarily cause thermal damage, whereas infrared waves cause chemical changes in biological tissues.

17) In the context of recombinant DNA technology, which of the following best explains the significance of sticky ends created by restriction enzymes?

A) Sticky ends eliminate the need for DNA ligase by creating complementary overhangs that spontaneously anneal and form stable recombinant molecules without further processing.
B) Sticky ends ensure that DNA fragments are cut at specific nucleotide sequences, allowing for the precise insertion of these fragments into vector DNA and enhancing the efficiency and specificity of recombination.
C) Sticky ends stabilize recombinant plasmids within host cells, thereby increasing the transformation efficiency and ensuring the reliable expression of inserted genes.
D) Sticky ends allow for the formation of recombinant DNA by providing overhangs that promote the annealing of complementary sequences from different DNA sources, which are then permanently joined by DNA ligase.

18) A point mutation is a type of genetic mutation where one of the base pairs in a DNA sequence is altered either by insertion or deletion.



Source: https://microbenotes.com/point-mutation/

In the diagram above, a mutation which results in a stop codon is the result of a

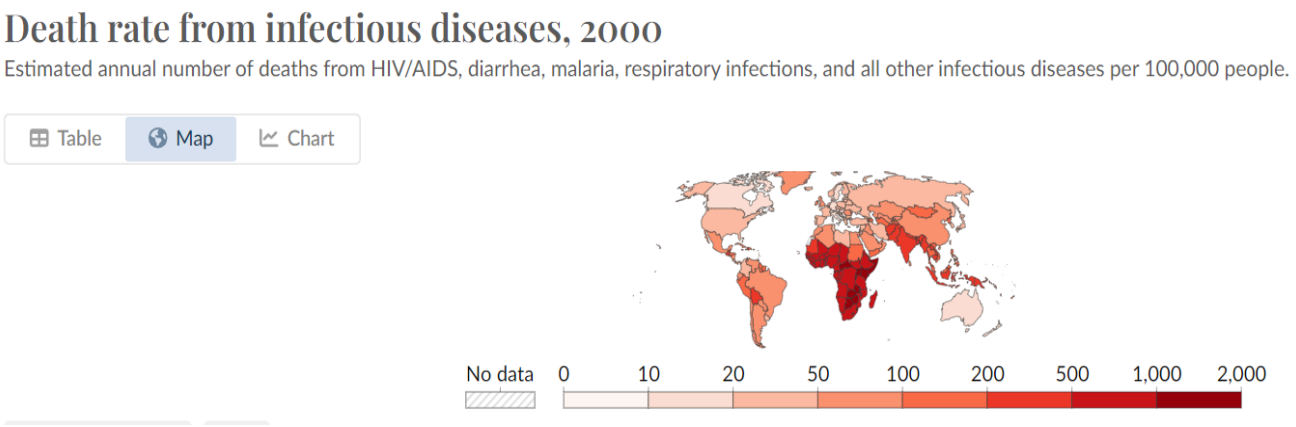
A) silent mutation
B) conservative missense mutation
C) nonsense mutation
D) non-conservative missense mutation

19) Which of the following best describes the process and implications of whole organism cloning?

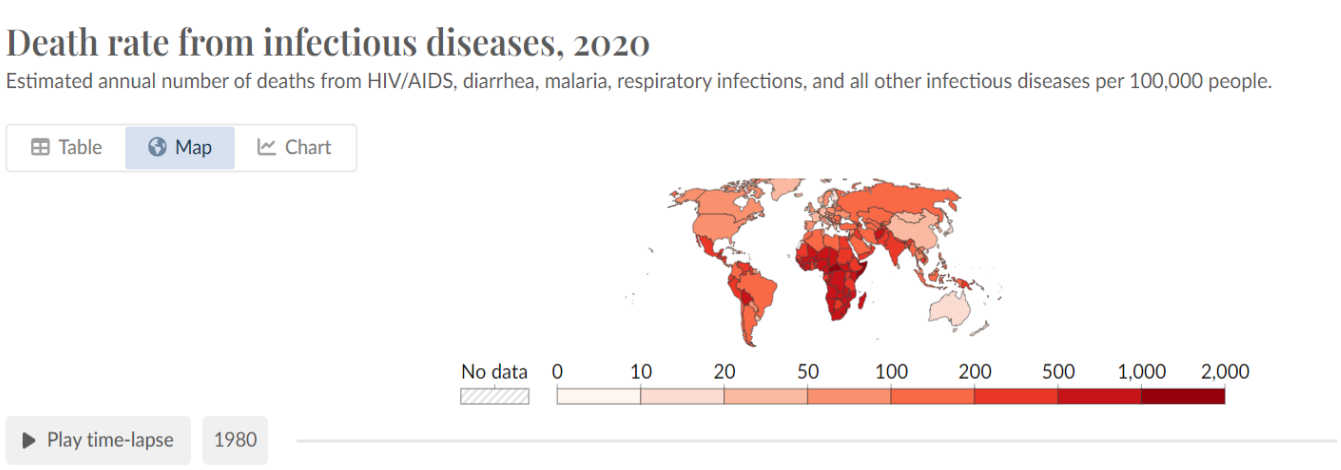
A) Whole organism cloning involves the insertion of a complete genome into an enucleated egg cell, resulting in offspring that are genetically identical to the donor but can exhibit different physical traits due to environmental factors.
B) Whole organism cloning entails the transfer of an organism's genetic material into a host species' egg cell, creating a hybrid organism with characteristics of both the donor and the host species.
C) Whole organism cloning always results in organisms that are not only genetically identical but also physically identical to the donor, as environmental factors have no influence on cloned individuals.
D) Whole organism cloning is primarily used to create organisms with enhanced abilities to reproduce sexually, ensuring genetic diversity in future generations.

20) Below are two heat maps which depict the annual estimated number of deaths per 100,000 people from infectious diseases.

Map A: Year: 2000



Map B: Year: 2020



Which of the following conclusions can be drawn from the data?

A) The global pandemic caused the increase in the number of deaths observed.
B) Australia has the lowest increase in death rate of infectious diseases compared to the other countries.
C) The northern hemisphere exhibited a more significant increase in death rate as a result of infectious diseases as compared to the southern hemisphere.
D) Many countries have exhibited an increase in death rates associated with infectious diseases.

PART B – SHORT ANSWER QUESTIONS

Attempt Questions 21-31

Allow approximately 2 hours and 30 minutes for this section

Question 21: The hypothalamus, located within the brain, consists of neurons that produce hormones. The hormones are transported along the neural axon eventually being emptied into blood vessels. The anterior pituitary gland, also located in the brain, absorbs the hormones delivered by these blood vessels. The anterior pituitary gland itself secretes a hormone that targets the adrenal glands that are located on top of the kidneys. A pathway is shown below in figure 1:

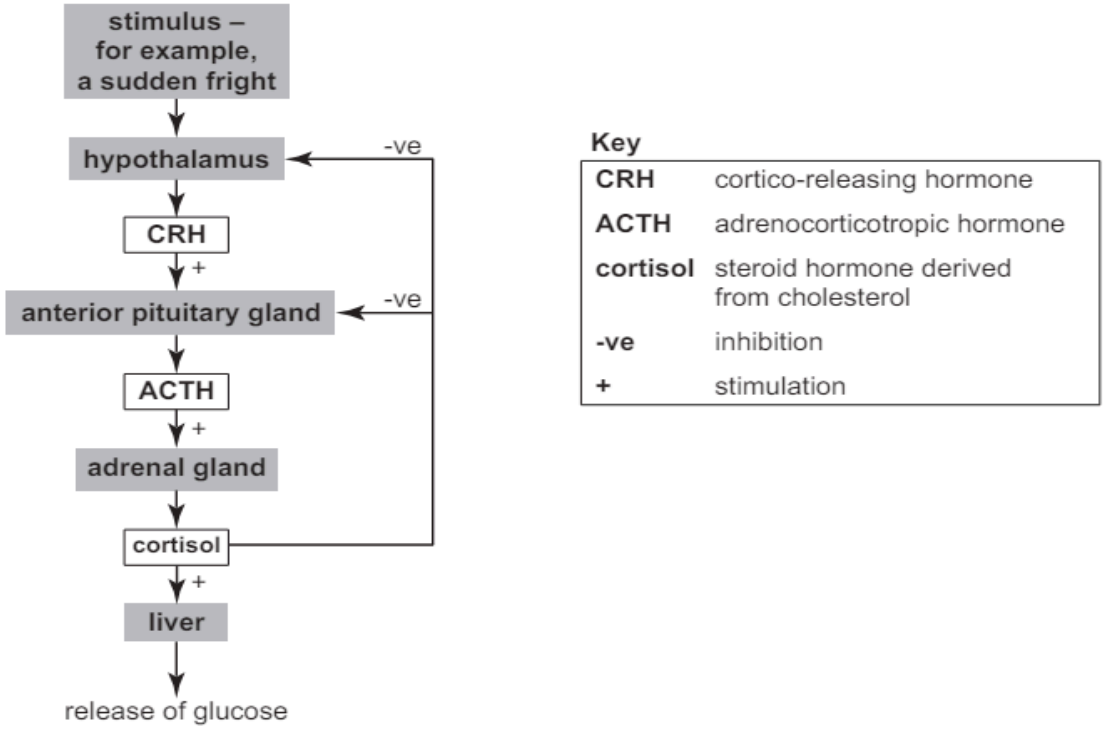


Figure 1: Stimulus response pathway for the release of glucose

(a) Describe the ways in which the anterior pituitary gland acts as both a receptor and effector in this pathway. **2m**

Receptor:……..

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Effector:……

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(b) The adrenal glands produce the 'stress' hormone, cortisol. Short periods of stress lead to a burst of cortisol production. Elevated levels of cortisol are detected by the hypothalamus and anterior pituitary gland. Describe how the actions of cortisol regulate levels of blood glucose **3m**

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Question 22:

Figure 2 shows the replication mechanism used by the herpes simplex virus.

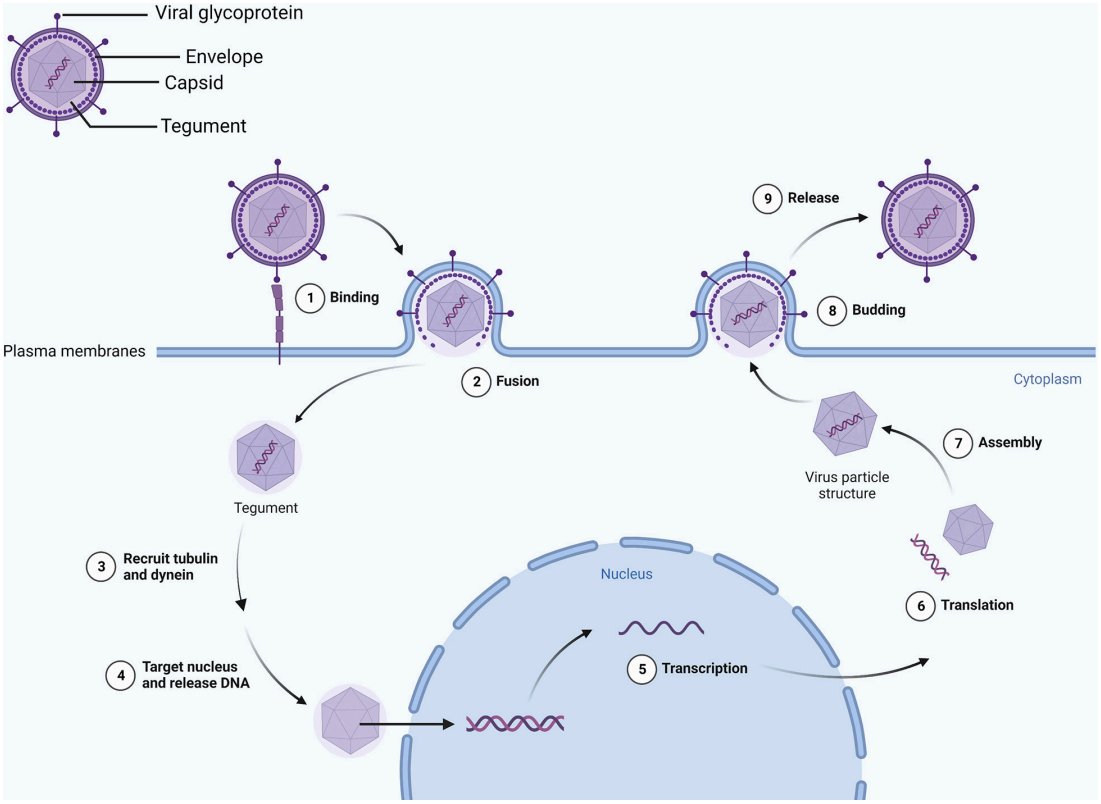


Figure 2: Replication mechanism used by the herpes simplex virus.

(a) Explain the differences between stage 5 (transcription) and stage 6 (translation) in the replication mechanism shown in figure 2. **6m**

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(b) *"Transmission of HSV infections occurs through close contact with a person shedding virus from a peripheral site, at a mucosal surface, or in genital or oral secretions."*
- Department of Health, Victoria 2023

(i) Identify the mode of transmission of the herpes simplex virus. **1m**

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(ii) A fomite refers to any inanimate object that can carry and spread disease and infectious agents. Explain why fomites are not considered to be important in the transmission of herpes simplex. **3m**

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(c) Herpes simplex viruses evade the immune system of their host by degrading MHC surface expression, disrupting the ability to alert the immune system of the presence of the pathogen. Describe one other adaptation used by viruses to help them to survive and reproduce in hosts. **3m**

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(d) Evaluate the likely outcomes of treating oral herpes with streptomycin (an antibiotic) and acicovir (an antiviral). **6m**

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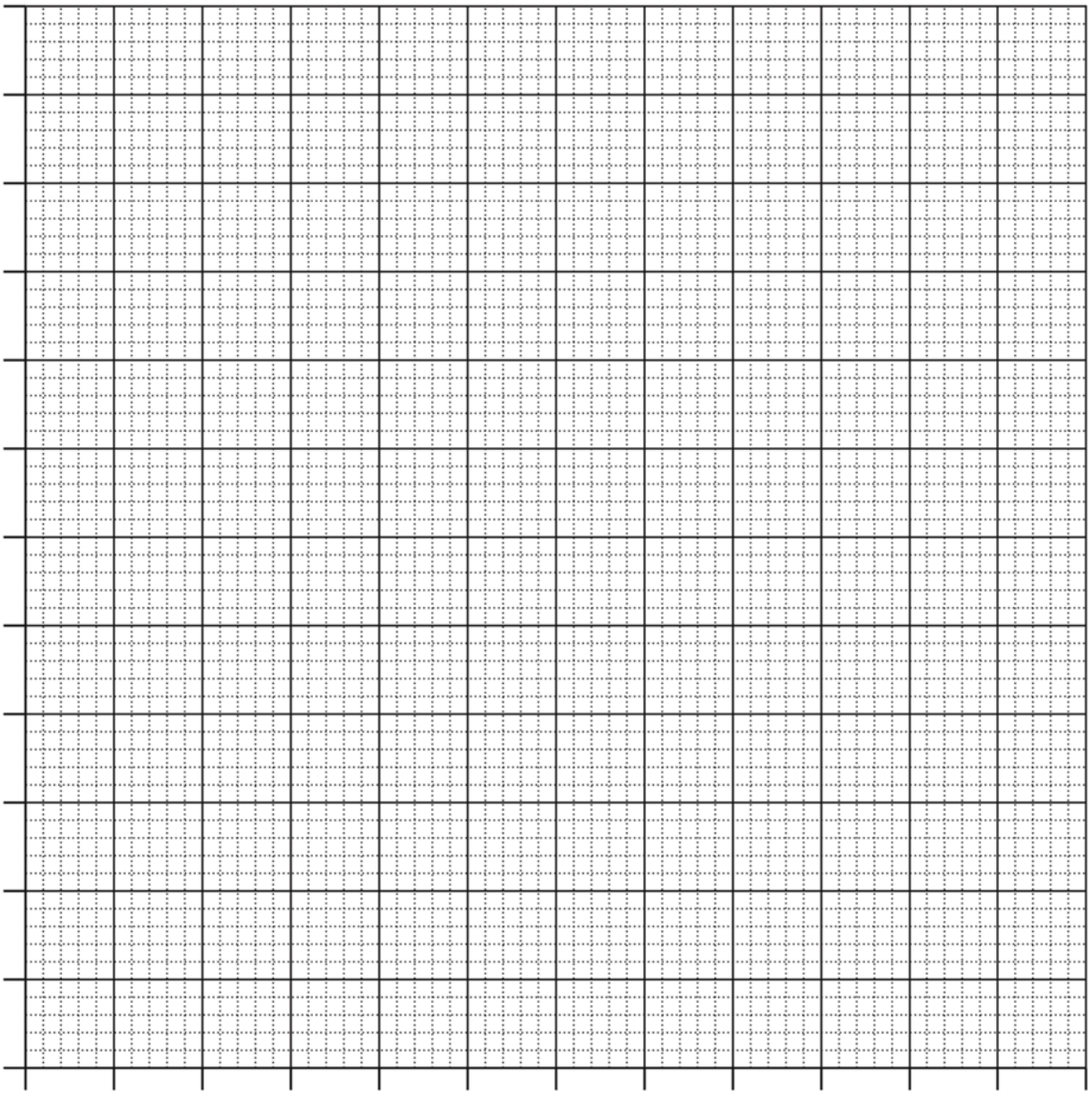
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QUESTION 23:

The following data shows the average amount of estradiol (a form of oestrogen) and progesterone produced by the average pregnant woman.

Week of Pregnancy	**Estradiol Level (ng/mL)**	**Progesterone Level (ng/mL)**
0	0	1
4	0.2	20.2
8	1.0	40.4
12	3.1	60.3
16	6.1	80.7
20	10.2	100
24	15.4	120.8
28	20.4	140.5
32	25.5	160.2
36	30.7	180.1
40	35.8	200.7

(a) Use the information provided to graph the levels of both hormones in a normal pregnancy. **4m**



(b) Explain the changes in both hormones shown over the span of an average pregnancy.
4m

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Question 24:

Figure 3 shows the average number of COVID-19 vaccine doses administered daily in Australia over a number of months. Figure 4 shows the average daily number of deaths linked with COVID-19 in Australia over a similar time period as figure X.

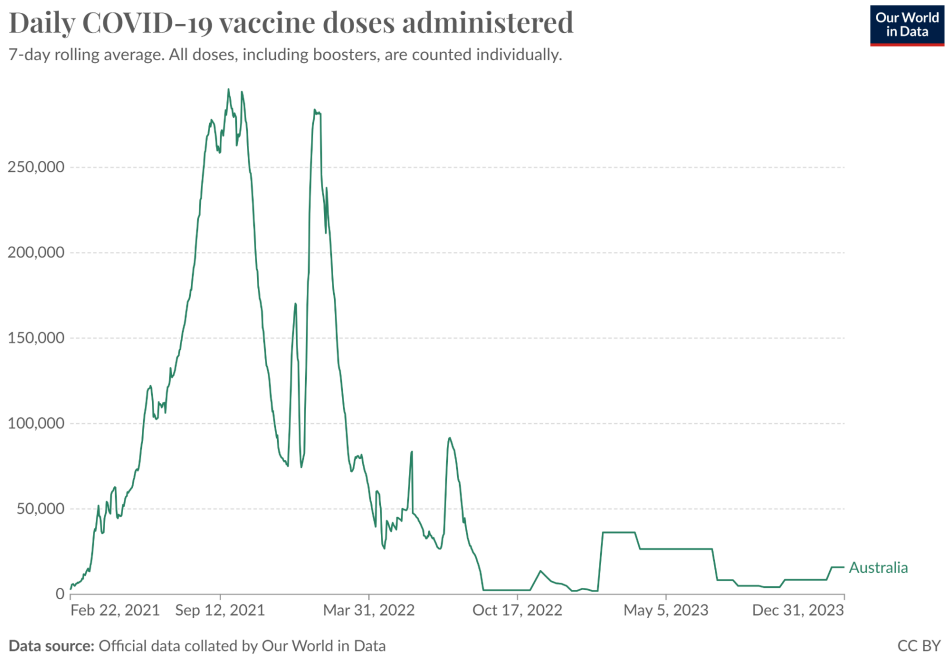


Figure 3: Average number of COVID-19 vaccine doses administered daily in Australia.

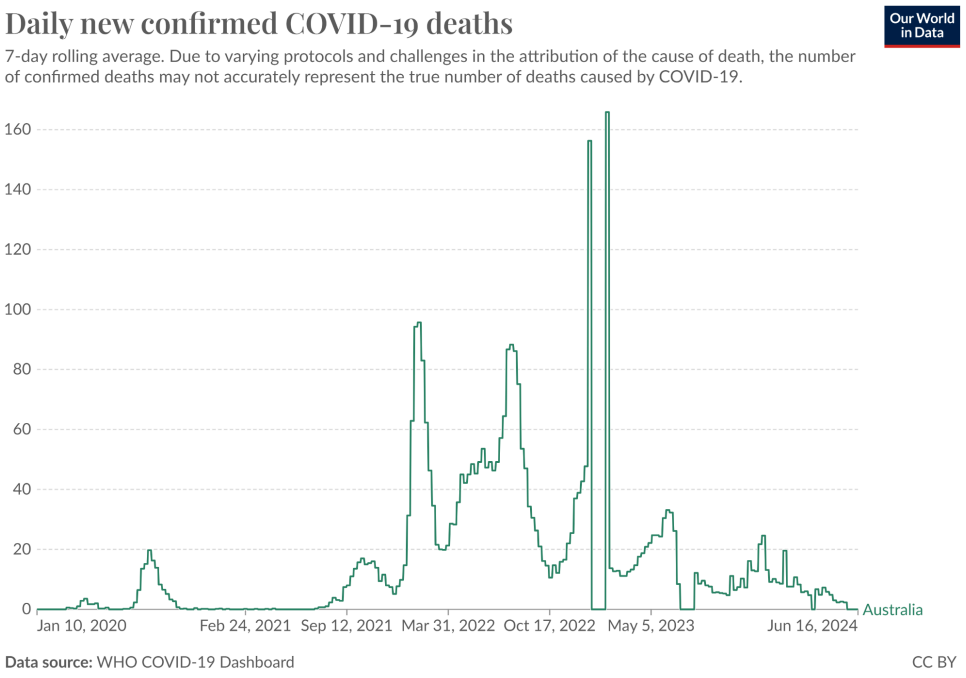


Figure 4: Average daily number of deaths linked with COVID-19 in Australia

Question 24 continued

By making reference to both figures, justify the use of COVID-19 vaccines in controlling the spread of COVID-19. **4m**

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Question 25:

Assess the contributions of Louis Pasteur and Robert Koch to the development of the Germ Theory of Disease. **6m**

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Question 26:

Figure 5 shows two methods which are used to give humans protection against disease. Method A shows active immunity and Method B shows passive immunity. Method A can be used against polio. Method B is often used against tetanus.

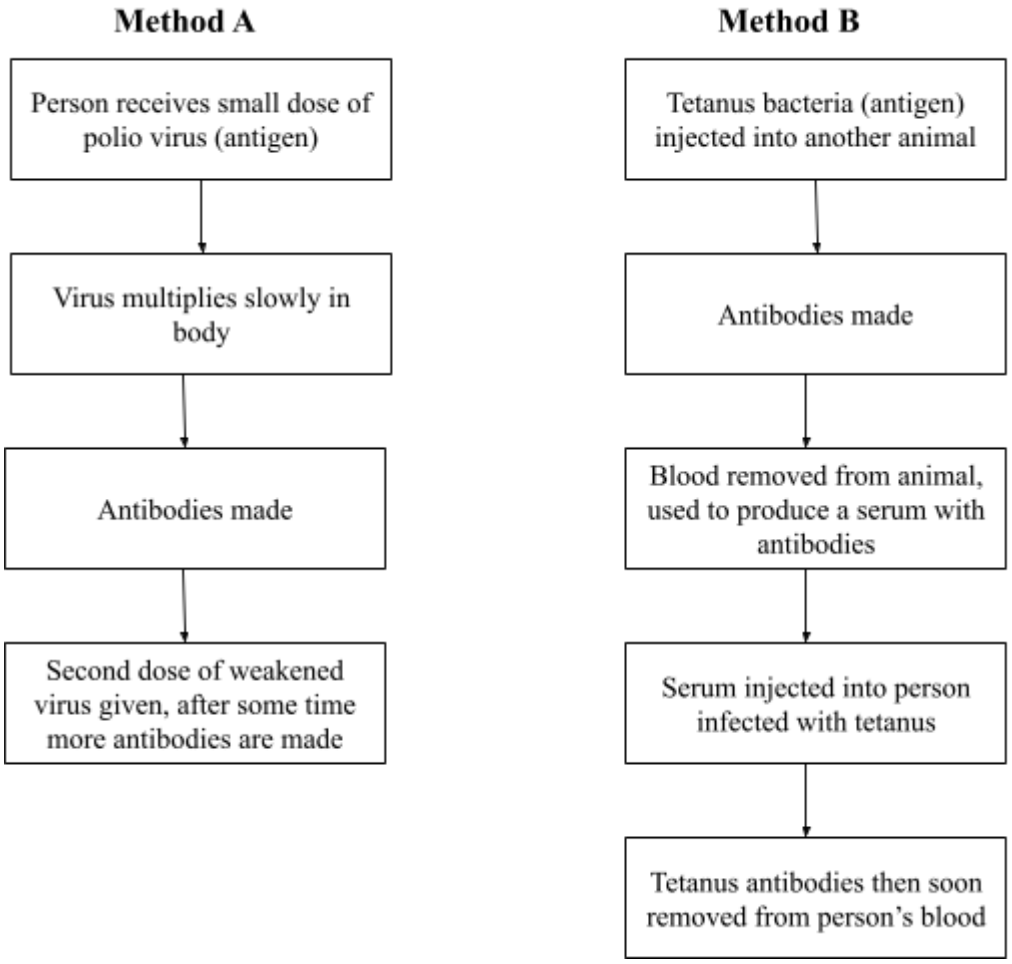


Figure 5: two methods used to give humans protection against disease

(a) Justify which method (A or B) would provide long lasting protection against their respective disease. **3m**

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(b) Explain why method A would not be helpful for treating a person who had just been infected with tetanus bacteria. **4m**

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Question 27:

Should we grow GM crops?
by Mary Nguyen

Bt cotton is a type of cotton that contains two genes from a soil bacterium, *Bacillus thuringiensis*, enabling it to produce insect-resistant proteins. Australian farmers of Bt cotton use only 15% of the quantity of the insecticide that was once needed to protect their cotton crops*. However, Bt cotton is not as resistant to the main insect pest of cotton crops, Helicoverpa, as it has been in the past*. In Australia, Bt cotton is picked by machine, but in India, it is picked by hand. Workers in India have developed skin allergies, which have been attributed to Bt cotton proteins. Traditionally, farmers have saved money by keeping seed from one year's crop to plant the following year. However, it is illegal for farmers to keep Bt cotton seeds because these seeds have been declared the legal property of the company Monsanto. Every year, cotton farmers must buy more seeds from Monsanto.

Unlike Monsanto, the company that produces the genetically modified food crop Golden Rice allows farmers to replant the rice they harvested the previous year. By inserting a gene from the bacteria *Erwinia uredovora* and another from a daffodil, *Narcissus pseudonarcissus*, into white rice, scientists produced Golden Rice – a rice variety containing higher levels of vitamin A†. People who eat Golden Rice avoid vitamin A deficiency. Trials conducted in several countries have shown that Golden Rice is safe to eat‡

References: *CSIRO, 'Cotton pest management', case study, ; †JA Paine et al., 'Improving the nutritional value of Golden Rice through increased pro-vitamin A content', Nature Biotechnology, 23, 27 March 2005, pp. 482–487; ‡A Coghlan, 'Golden Rice gets approval in the US', NewScientist, magazine issue 3180, 2 June 2018

(a) Both BT cotton and Golden Rice may be classified as a genetically modified organism. Explain how they may also be both classified as a transgenic organism.
3m

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(b) Complete the table below by describing one social and one ethical implication relevant to the use of Bt cotton and Golden Rice. The same implication should not be used twice. **4m**

	Social Implications	Ethical Implications
BT Cotton		
Golden Rice		

Question 28:

(a) Figure 6 illustrates nondisjunction in various stages of meiosis. Fill in the blanks within figure 6 and outline the number of chromosomes in each gamete.

6m

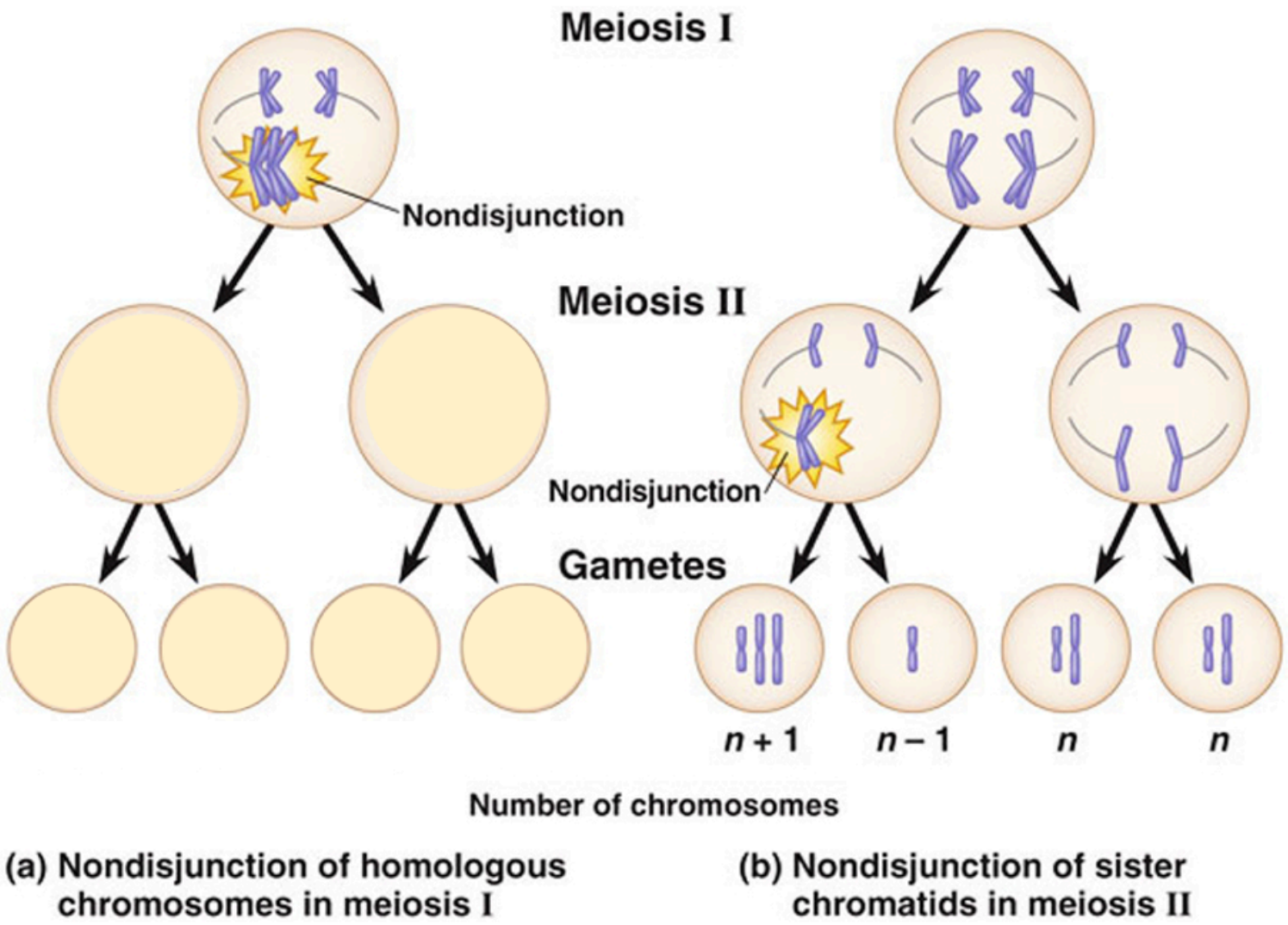


Figure 6: Diagram showing nondisjunction in various stages of meiosis.

(b) A student completed a research project into nondisjunction occurring within meiosis I and concluded that the effects of nondisjunction during Meiosis II is more severe in an individual than if nondisjunction occurs in Meiosis I. With reference to the diagram, justify if the student's conclusion is correct. **4m**

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Question 29:

Explain the difference between point mutations and chromosomal mutations. **4m**

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Question 30:

Tuberculosis (TB) is a contagious and potentially severe infectious disease primarily caused by the bacterium Mycobacterium tuberculosis. It most commonly affects the lungs, but can also impact other parts of the body. When TB bacteria invade the lungs, the body's immune response is activated to contain the infection. This leads to the formation of granulomas, which are organized clusters of cells that attempt to isolate and control the bacteria. Describe how the formation of a granuloma decreases the ability of Mycobacterium tuberculosis to evade the immune system in patients with tuberculosis (TB). **4m**

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Question 31:

Beehives consist of up to 40 000 honey bees. The majority of these bees are female worker bees. There is only one queen bee. She is a diploid female (2n = 32) and she is the bee that lays the eggs for the colony. The queen bee lays two different types of eggs:

• Type 1 – Those eggs that have been fertilised by sperm give rise to females that become either worker bees or other queen bees.

• Type 2 – Those eggs that have not been fertilised by sperm give rise to male drone bees.

(a) How many chromosomes are there in the somatic cells of the following bees?

2m

Female worker bee: ……

Male drone bee: ……

(b) Even though they come from unfertilised eggs, male drone bees show genotypic variation. Describe two mechanisms by which this can occur.

4m

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END OF EXAMINATION

STUDENT NUMBER ……..

MULTIPLE CHOICE ANSWER SHEET

Place an X in the correct cell to indicate your response. If you make a mistake, completely scribble out the incorrect response and clearly label your correct answer.

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