JAMES RUSE AGRICULTURAL HIGH SCHOOL

2022

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Biology

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen.
- Draw diagrams using pencil.
- NESA approved calculators may be used.
- Write your Student Number at the top of the response sheet on page 15

Total Marks – 100

Section I – Pages 3 – 13

20 marks

- Attempt Questions 1 – 20
- Allow about 35 minutes for this part

Section II – Page 17 – 38

80 marks

- Attempt Questions 21– 33
- Allow about 2 hours and 25 minutes for this section

There are no questions on this page

Section I

20 marks

Attempt Questions 1 – 20.
Complete the multiple choice answer sheet on page 15.

---

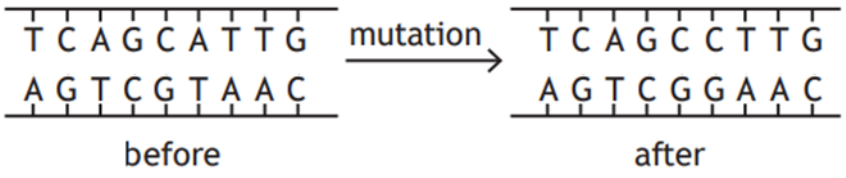
1 The table identifies the conditions associated with a variety of ploidy changes.

Chromosome number ploidy	**Condition name**
Partial monosomy 5	Cri du chat syndrome
Trisomy 21	Down syndrome
Trisomy 23	Klinefelter syndrome
Monosomy 23	Turner syndrome

For a person with XXY chromosomes, which condition could they have?

A. Cri du chat syndrome
B. Down syndrome
C. Klinefelter syndrome
D. Turner syndrome

2 The diagram below shows part of a DNA molecule before and after a mutation.



What type of mutation is presented in the diagram?

A. Deletion
B. Substitution
C. Insertion
D. Inversion

3 Which of the following explains the separation of DNA fragments in gel electrophoresis?

A. Longer fragments of DNA travel the fastest as they are more charged.
B. Fragments move to the positive terminal because phosphate groups are negative.
C. Fragments move to the negative terminal because deoxyribose groups are positive.
D. Shorter fragments get stuck in the holes in the gel and travel the slowest

Questions 4 & 5 refer to the following information.

A *diversity index* is a mathematical measure of species *diversity* in a community. In a recent study, a zoologist investigated some populations of Koalas and measured the amount of genetic diversity in each. Values of the diversity index range from 0 (no diversity) to 1 (maximum diversity).

Population	**Diversity Index**
Framlingham Forest	0.606
Mt. Eccles	0.597
Sandy Point	0.032
Raymond Island	0.419

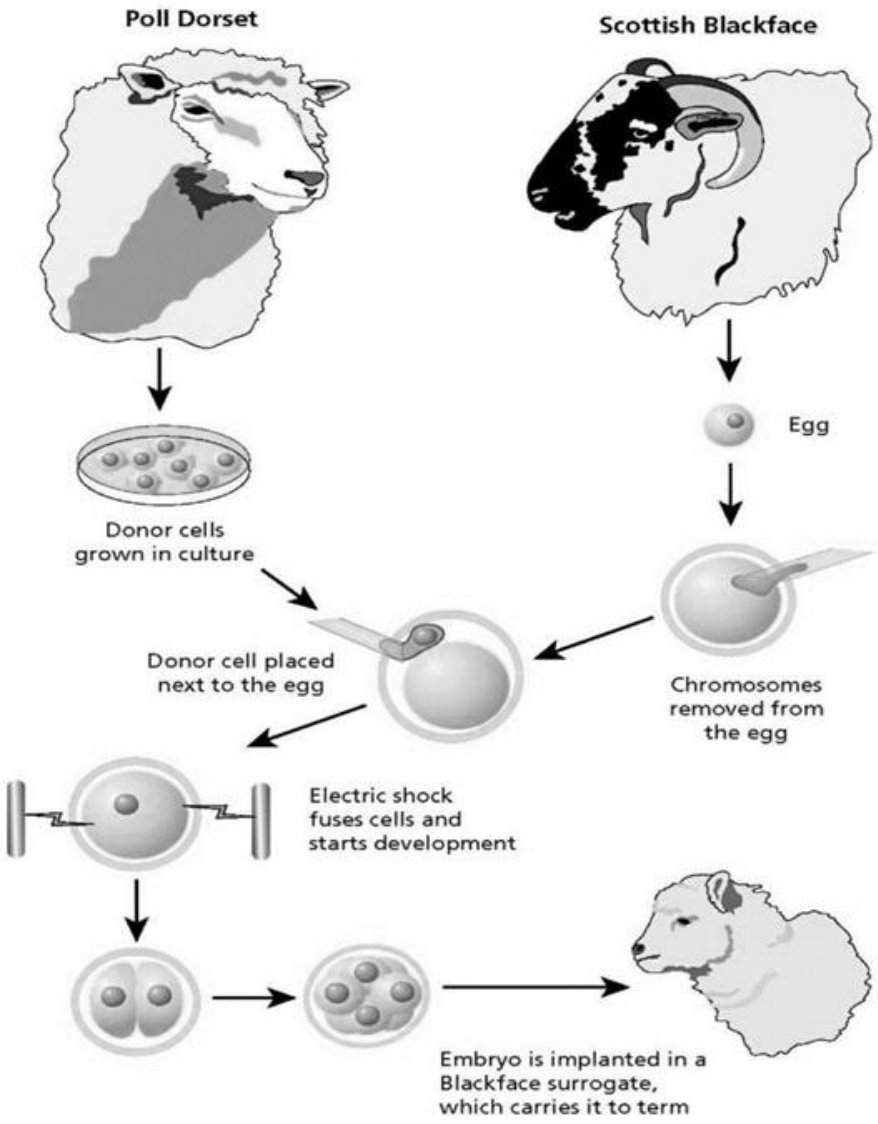
4 On the basis of the information in the table, which of the following koala populations is at the greatest risk of extinction due to genetic factors?

A. Framlingham Forest
B. Mt. Eccles
C. Sandy Point
D. Raymond Island

5 Which of the following processes could introduce a new allele into a koala population?

A. Genetic drift
B. Natural selection
C. Mutation
D. Mitosis

6 The following diagram shows the process of cloning a sheep.



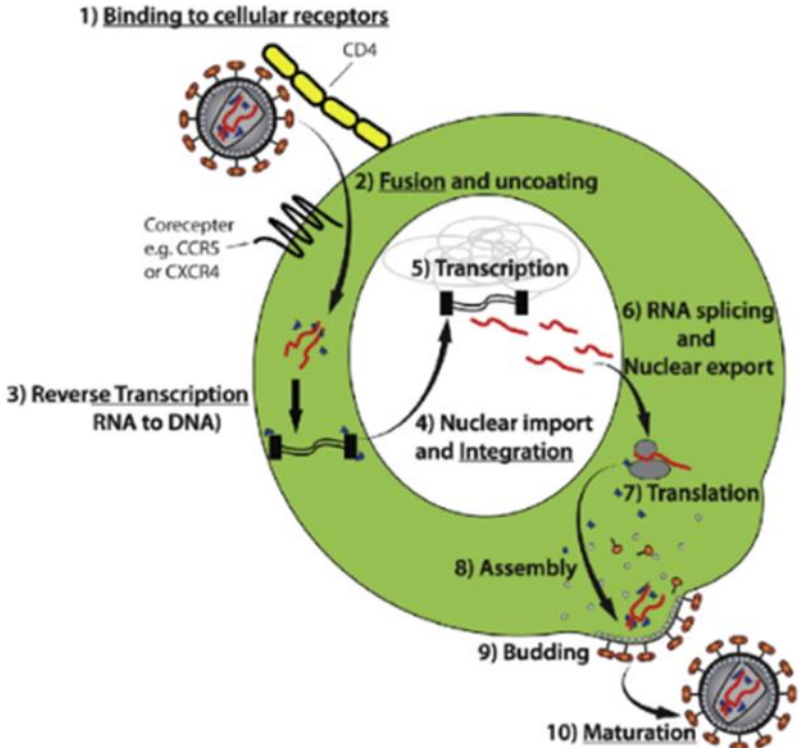
Which organism will the cloned lambs most likely resemble?

A. Poll Dorset
B. Scottish Blackface
C. The surrogate
D. A cross between the egg donor and the somatic cell donor.

7 Which of the following is always true of a germline mutation?

A. It is passed on to offspring.
B. It is not present in gametes.
C. It is present in most of the cells in an organism.
D. It is only present in copies of the cell that the mutation occurs in.

8 The diagram below shows the life cycle of a pathogen.



Which of the following correctly represent information about the pathogen?

	Classification	Type	Host
A.	Cellular	Fungus	Human
B.	Non-cellular	Bacteria	Plant
C.	Cellular	Prion	Bacteria
D.	Non-cellular	Virus	Animal

9 A new non-fatal human disease outbreak was observed in a region. It is suspected that a specific virus is responsible for the outbreak. A group of researchers conducted experiments on the relation between the virus and disease cause. The following observations were made:

The virus cannot be grown using artificial nutrient media, but it can be grown in cultured human cells.
The virus cannot be isolated from other human viruses.

Which of the following factors would make it impossible to use Koch's postulates to support a claim that the virus was responsible for the disease?

A. The difficulty in isolating the virus from other viruses.
B. The inability to grow the virus using artificial nutrient media.
C. Koch's postulates apply only to bacteria.
D. The fact that the disease is non-fatal.

10 Technology can be used to assist people with either hearing or visual disorders. A person with myopia can be prescribed spectacles to correct their vision.

Which of the following correctly links the problem with the technological solution?

	Problem causing myopia	**Correction with spectacles**
A.	Eyeball is too long and images fall in front of the retina, causing blurred vision.	Concave lenses in spectacles focus the images onto the retina.
B.	Eyeball is too long and images fall in front of the retina, causing blurred vision.	Convex lenses in spectacles focus the images onto the retina.
C.	Eyeball is too short and images fall behind the retina, causing blurred vision.	Concave lenses in spectacles focus the images onto the retina.
D.	Eyeball is too short and images fall behind the retina, causing blurred vision.	Convex lenses in spectacles focus the images onto the retina.

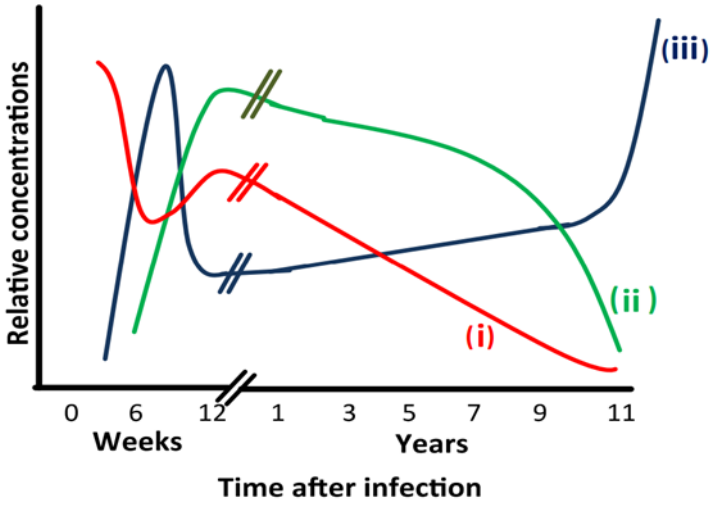
11 Potato plants can be reproduced by seeds or by stem tubers. Stem tubers are organs for vegetative propagation.

Which of the following comparisons between these two methods of reproduction is correct?

	Property	Seed	Stem tuber
A.	Genetic variation in offspring	smaller	greater
B.	Chromosome number of the cells of offspring	haploid	diploid
C.	Chance of dispersal of offspring	smaller	greater
D.	Chance of passing infectious diseases to offspring	smaller	greater

12 Primary infection by HIV results in flu-like symptoms 2-3 weeks after exposure, at which point the patient is highly infectious. Latent infection follows, with few symptoms for many years as the immune system suppresses the virus, with only some white blood cells infected. As the virus continues to multiply and destroy immune cells, severe disease manifests in the form of AIDS.

The graph below shows the concentration of viral pathogen cells, T-cells, and antibodies against HIV that develop in time in an untreated patient:



Which of the following would match the above graph for the lines marked (i), (ii) and (iii), respectively?

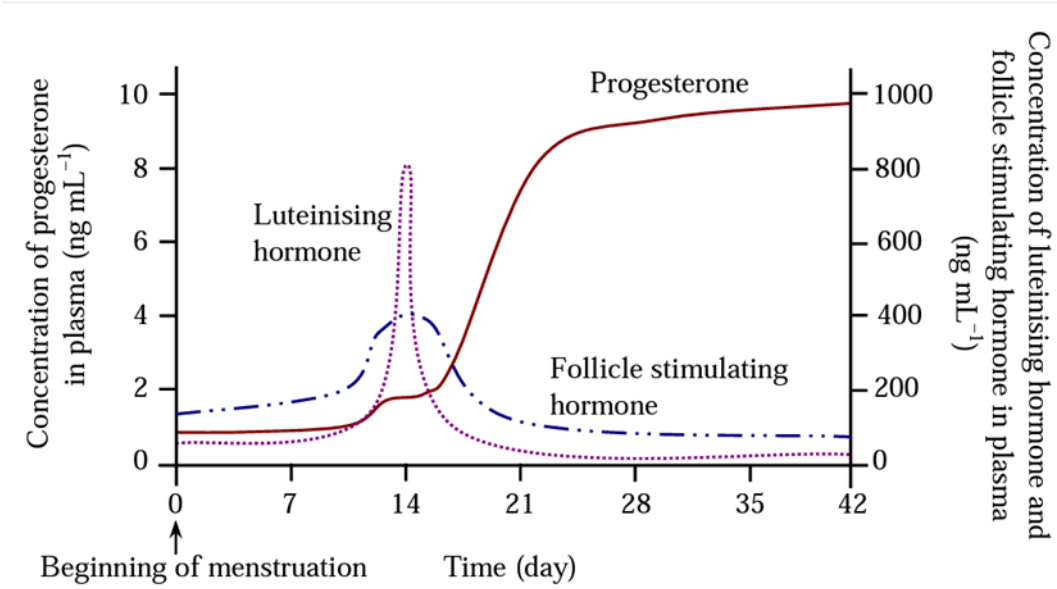
A. Virus, T-cells and antibodies.
B. T-cells, virus and antibodies.
C. T-cells, antibodies and virus
D. Antibodies, T-cells and virus

13 Which of the statements below are correct with respect to external fertilisation?

(i) The male and female gametes are formed and released simultaneously.
(ii) Many gametes must be released into the medium.
(iii) Offspring formed because of external fertilisation have a better chance of survival than those formed inside an organism.
(iv) Large numbers of offspring are produced.

A. (iii) and (iv)
B. (ii) and (iv)
C. (i) and (ii)
D. (i) and (iii)

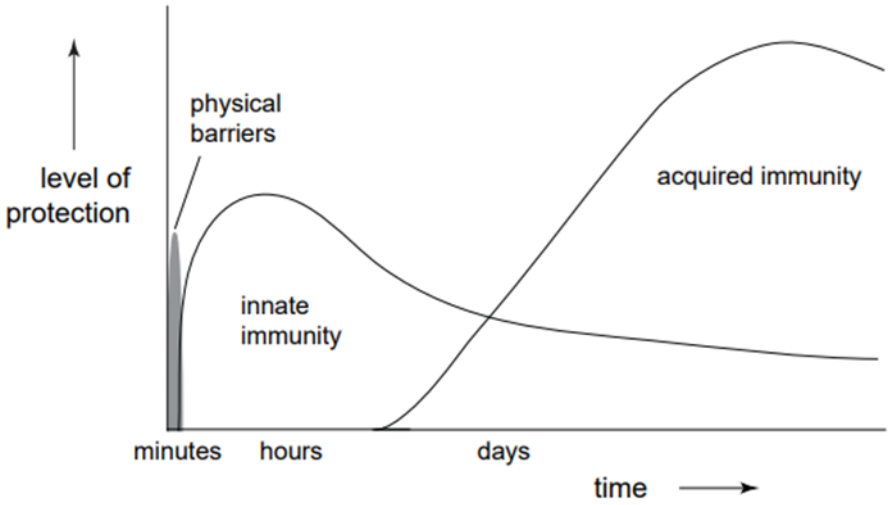
14 The following graph shows the plasma concentrations some reproductive hormones in a woman over a period of time:



Which of the following is consistent with this graph?

A. Ovulation occurred at day 21 for this cycle.
B. The next menstrual bleed was at day 28 for this cycle.
C. Oestrogen levels peaked at day 12 for this cycle.
D. Human chorionic gonadotrophin levels peaked at day 16 for this cycle.

15 The graph below is the timeline of immune system activities in response to a microbial infection.



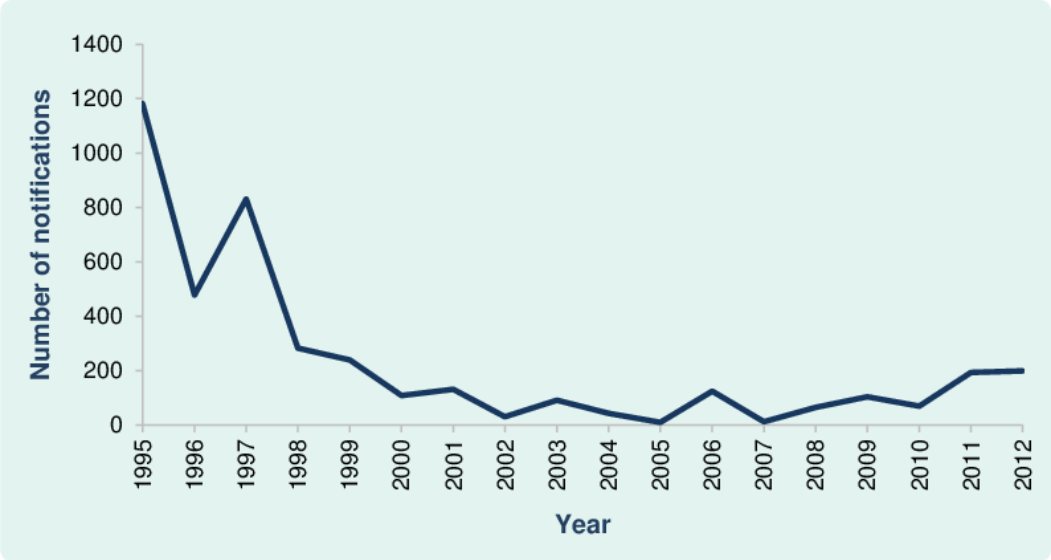
Which of the following statements are consistent with the graph?

A. The duration of the protection offered by physical barriers is short as it involves macrophages.
B. The immune system activities cease post-infection.
C. The inflammation response destroys the pathogen using phagocytosis.
D. Acquired immunity offers the maximum level of protection due to the involvement of lymph nodes.

16 Which of the following are involved with the prevention of bacterial infections in different parts of the human body?

	Alimentary canal	**Respiratory tract**	**Blood**
A.	digestive enzymes	hair	white blood cells
B.	mucus	cilia	red blood cells
C.	acid	mucus	blood platelets
D.	bile salts	enzymes	leucocytes

17 Consider the following graph of incidence of measles in Australia from 1995 – 2012.



Which of the following set of changes in the population is inconsistent with the data shown in the graph during the period 2007 – 2012?

	Mobility	Immunity
A.	Decreased	Decreased
B.	Decreased	Increased
C.	Increased	Decreased
D.	Increased	Increased

18 In mice, the agouti gene controls the deposition of yellow and black pigment in developing hairs. The allele A causes agouti banding of hairs and is dominant to the allele a, so that recessive mice are solid black. However, a separate gene (C) is necessary for pigment production. A recessive c allele at this locus is unable to produce pigment and the mouse is albino regardless of the allele present at the agouti locus. The two genes are located on different autosomal chromosomes.

What is the expected phenotypic ratio for the cross CcAa X ccaa ?

A. 2 agouti: 1 black: 1 albino
B. 1 agouti: 2 black: 1 albino
C. 1 agouti: 1 black: 2 albino
D. 1 agouti: 1 albino

Use the following information to answer questions 19 and 20.

Patients with end stage kidney disease often undergo dialysis procedures while waiting for a kidney transplant. If a donor kidney becomes available, it is grafted to an artery, a vein and a ureter, usually leaving the diseased kidney in place. Typically, the patient takes a suite of anti-rejection medications while the transplant it in place. Among these medications are ones which prevent activation of lymphocytes.

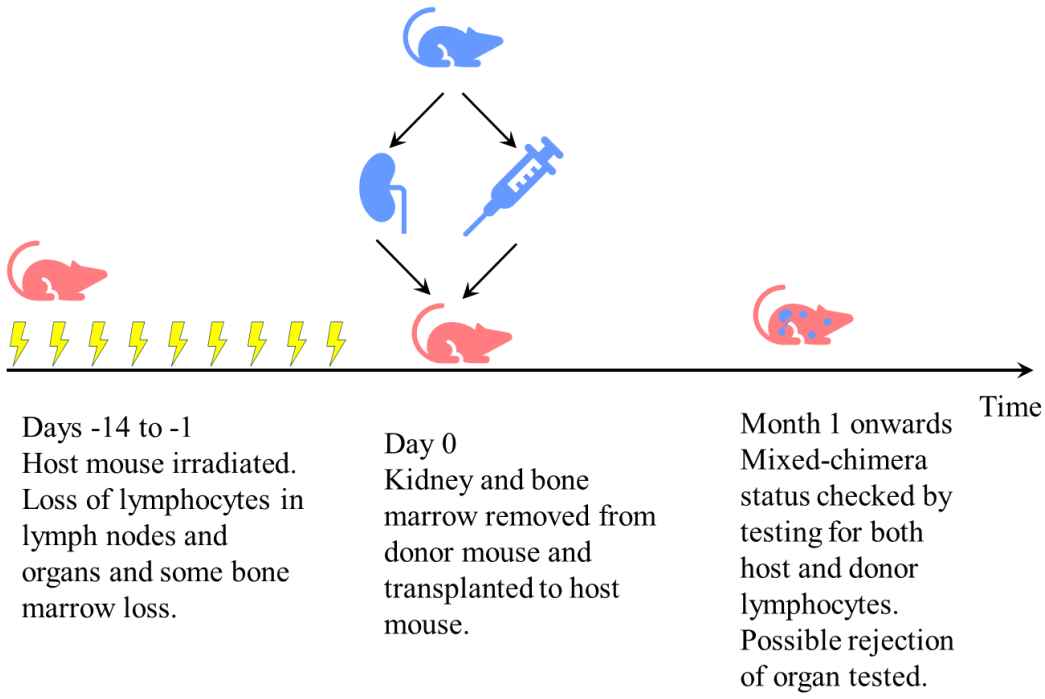
The patient is closely monitored for a range of side effects as well as for graft rejection (transplant failure). Kidneys transplanted in this way are commonly rejected between 5 to 15 years after grafting, and although many patients receive successive transplants, each transplant is more difficult to perform successfully.

19 Which of the following is correct about the effect of anti-rejection medications?

A. They prevent the donor's antibodies from attacking the tissue of the host.
B. They prevent the donor's T cells from attacking the tissue of the host.
C. They reduce the need for dialysis while the patient is healing from surgery.
D. They increase the risk of infection and cancer in the patient.

Question 20 is on page 13

A new treatment protocol in mice has shown promise in reducing the need for anti-rejection medications and improving the long-term success of transplants. Both a kidney and bone marrow from the donor are transplanted, with the aim to produce a mixed-chimera status in which lymphocytes from both the host and the donor are produced.



The host mice demonstrated significantly longer time until transplant rejection than a control group of unirradiated host mice who also received a transplant. Neither group received anti-rejection drugs.

This type of procedure has been used experimentally in some human patients, without graft rejection or the extended use of anti-rejection medication.

20 What is the purpose of the irradiation prior to transplant?

A. To increase the mutation rate of the host's lymphocytes so that some will recognise the donor tissue as self.
B. To increase the mutation rate of the donor tissue so that some is recognised by the host immune system as self.
C. To kill some lymphocytes of the host so that there is space for the donor's bone marrow.
D. To kill some lymphocytes of the host so that no immune response can be mounted.

There are no questions on this page

Mark: .....

Section I

Multiple Choice Answer Sheet

1.	A □	B □	C □	D □
2.	A □	B □	C □	D □
3.	A □	B □	C □	D □
4.	A □	B □	C □	D □
5.	A □	B □	C □	D □
6.	A □	B □	C □	D □
7.	A □	B □	C □	D □
8.	A □	B □	C □	D □
9.	A □	B □	C □	D □
10.	A □	B □	C □	D □
11.	A □	B □	C □	D □
12.	A □	B □	C □	D □
13.	A □	B □	C □	D □
14.	A □	B □	C □	D □
15.	A □	B □	C □	D □
16.	A □	B □	C □	D □
17.	A □	B □	C □	D □
18.	A □	B □	C □	D □
19.	A □	B □	C □	D □
20.	A □	B □	C □	D □

/20

There are no questions on this page

Section II – 80 marks
Attempt Questions 21 – 33
Allow about 2 hour and 25 minutes for this part.

- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations

---

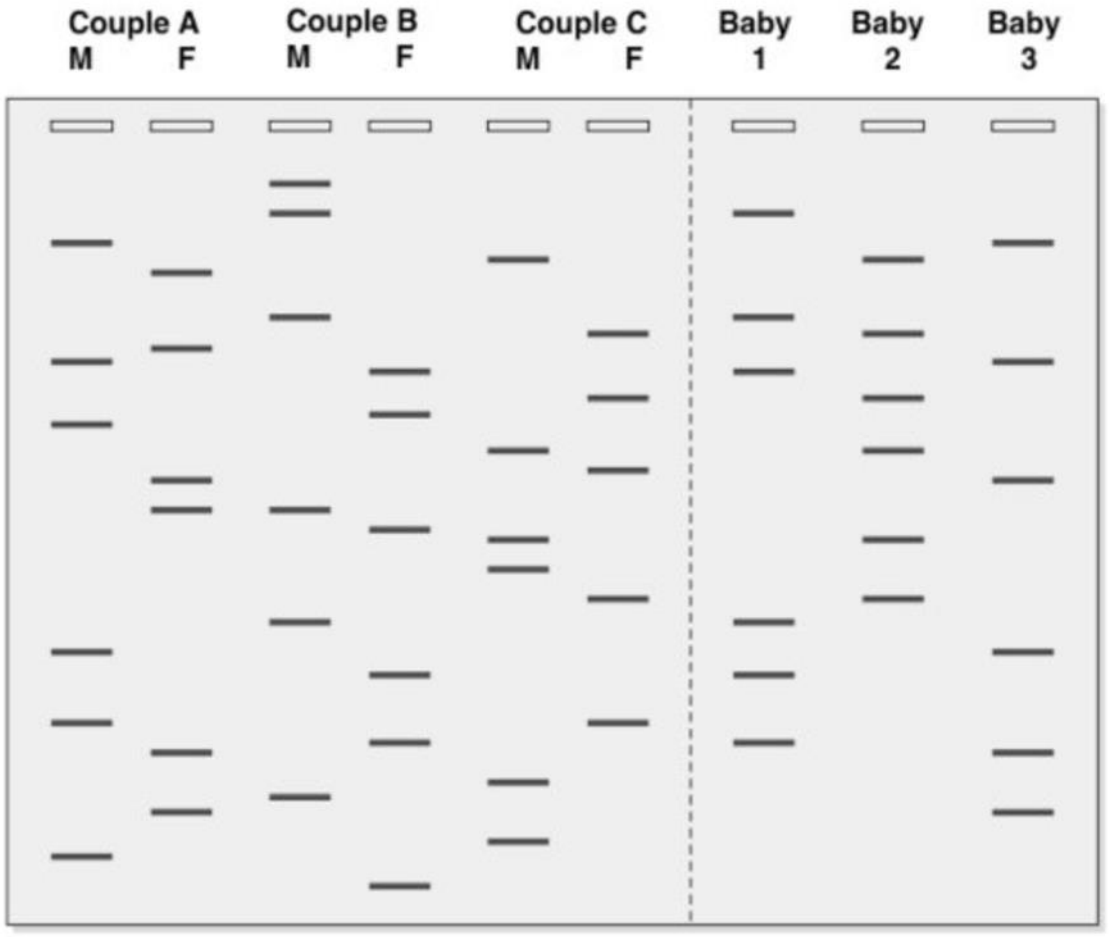
Question 21 (4 marks)

Mutagens can induce changes in DNA. Complete the following table on the three types of mutagens. **4**

Mutagen Category	**Explanation**	**Example Disease**
	Causes the formation of dimers or can create free radicals	
	Can insert between base pairs causing framsehifts.	
	Can slip through both cell and nuclear membranes and interact with DNA directly altering DNA sequence.	

Question 22 (2 marks)

In a hospital, an emergency occurs during which three babies are mixed up. The staff quickly organise a number of tests. The results of a DNA profile are shown below:



.

Correctly match the baby to the parent couple. **2**

Baby 1……

Baby 2……

Baby 3……

Question 23 (3 Marks)

Glucocorticoid (GC) is a hormone produced in the rat pituitary gland that promotes the production of the growth hormone protein (GH), which is responsible for postnatal growth and control.

Using the information above, outline the main steps that pituitary cells use to make proteins such as growth hormone. **3**

……

……

……

……

……

……

……

Question 24 (3 Marks)

Large-scale collaborative projects have been useful in studying population genetics.

Evaluate this statement using trends, patterns and/or relationships identified in ONE study. **3**

……

……

……

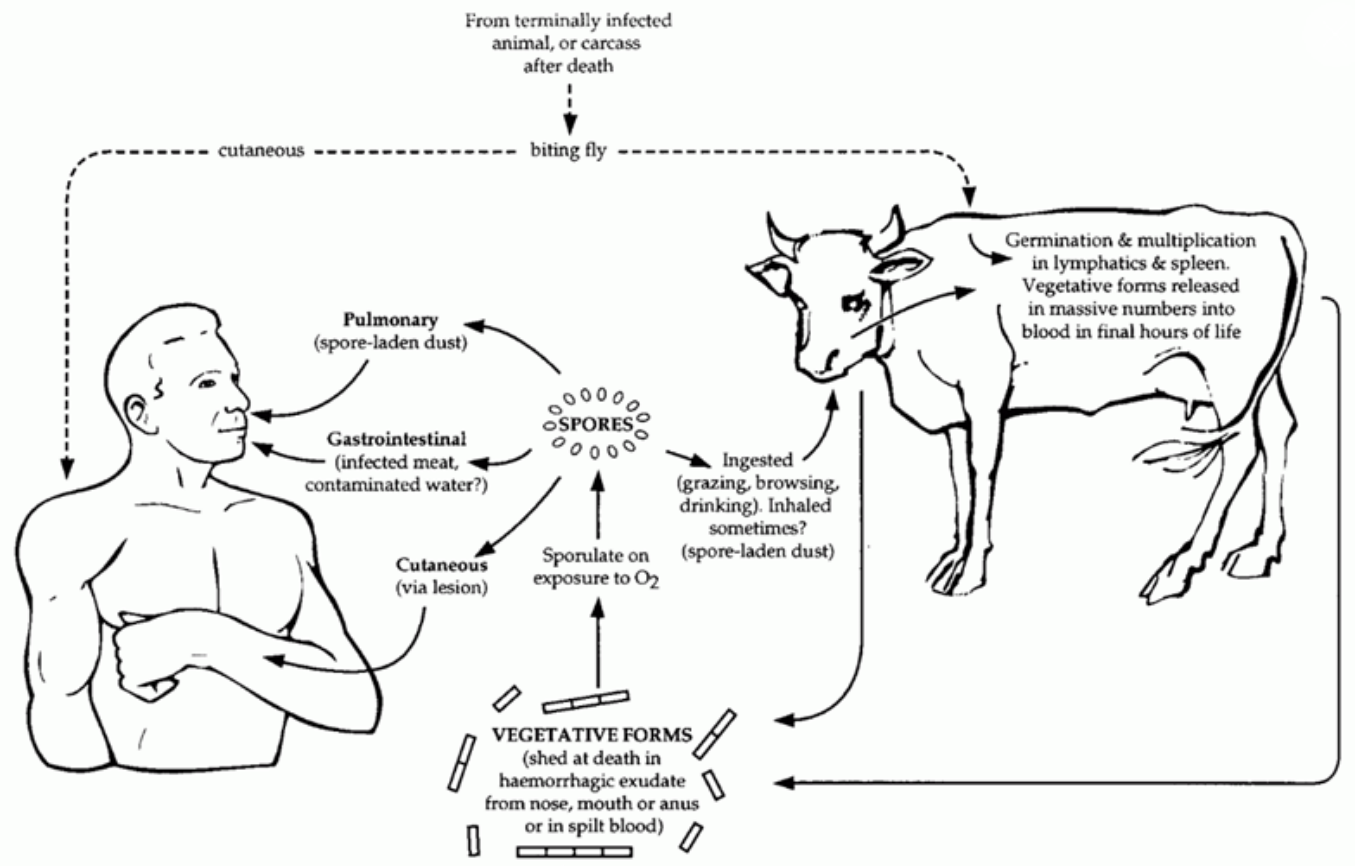
……

……

……

Question 25 (4 Marks)

Bacillus anthracis is the bacteria that causes anthrax, a skin infection that is often fatal.



(a) Use the information provided to identify TWO transmission methods of the pathogen to a new host. **2**

……

……

……

……

(b) Propose TWO appropriate control measures to prevent the spread of anthrax. Use your knowledge from the course justify the proposed actions. **2**

……

……

……

……

Question 26 (2 Marks)

A study was undertaken to investigate the incidence of acute injuries and soccer-related chronic pain from long-term training and during matches in adolescent players using natural grass turfs (NGT) compared to artificial turfs (AT) (Aoki et al).

Youth soccer players aged 12-17 years from 6 teams participated – 301 in total completed the study. Medically diagnosed acute injuries and chronic pain per 1000 player hours, were recorded daily by team health care staff throughout 2005 and they were evaluated according to frequency of surface used most of the time.

There was no significant difference in the incidence of acute injuries between the two surfaces during training and competition. However, the artificial turf group showed a significantly higher incidence of low back pain during training. Of the 301 soccer players 135 played on AT and of these players, 45 had low back pain, the rest dis not. A total of 79 players had lower back pain regardless of what surface was played on.

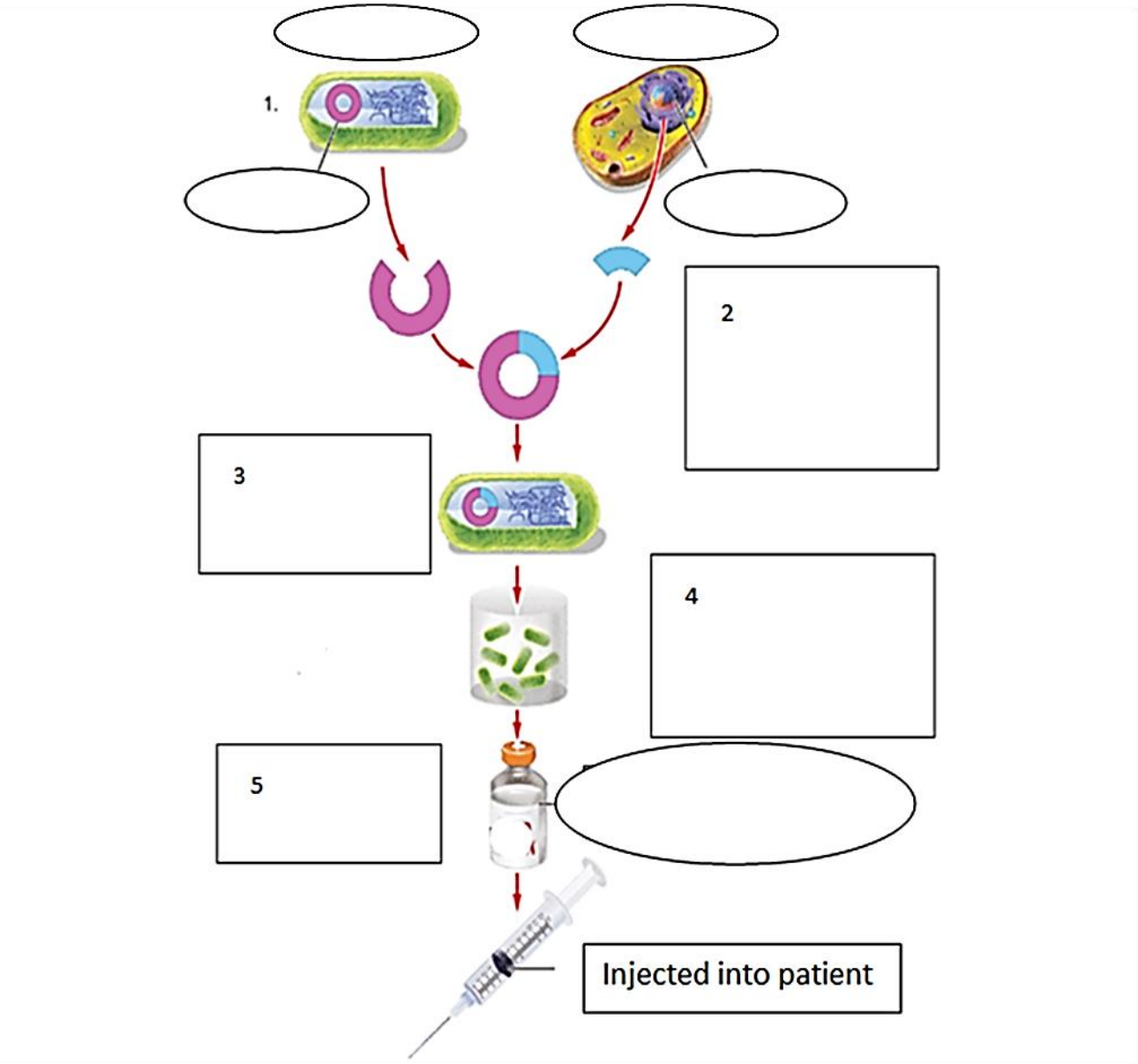
Identify the specific study design that has been used by Aoki and colleagues by ticking the appropriate box(es). Higher marks will be awarded to responses that tick only the correct box(es).
2

prospective	retrospective	cohort	case-control	cross-sectional
case	longitudinal	clinical trial	blind	double-blind

Question 27 (11 Marks)

The diagram shows the process of producing a transgenic species to produce insulin.

(a) Complete the labels (in ovals) and steps (numbered in boxes) in the spaces provided in the diagram. **4**



Question 27 continues on page 23

(b) Ethical issues arise from the use of transgenic species. Outline TWO advantages and TWO disadvantages, including ethical considerations, of a named transgenic species not used elsewhere in this examination paper. **4**

……

……

……

……

……

……

……

……

(c) Discuss how reproductive technologies can impact on the genetic diversity of species. Use examples to support your answer. **3**

……

……

……

……

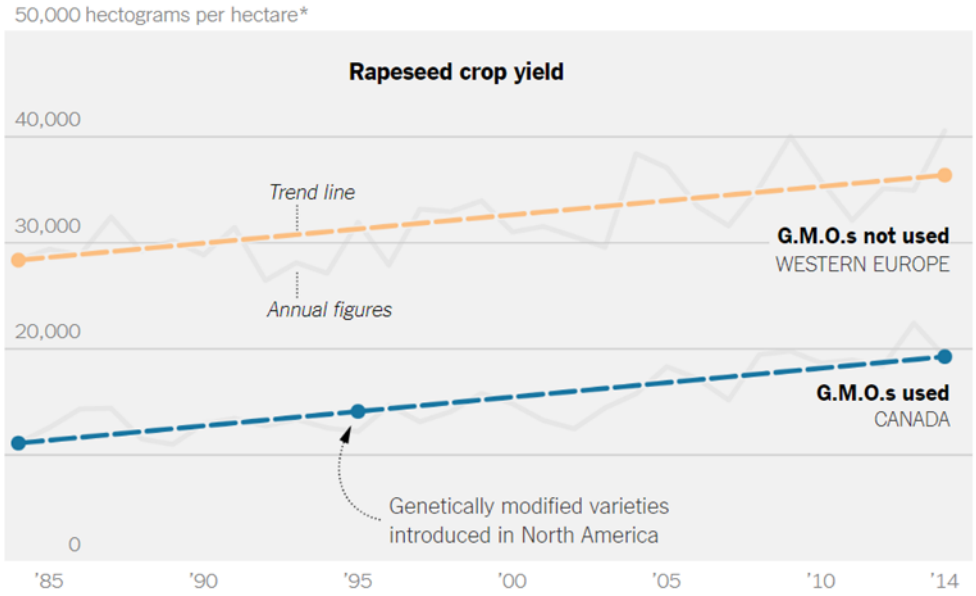
……

……

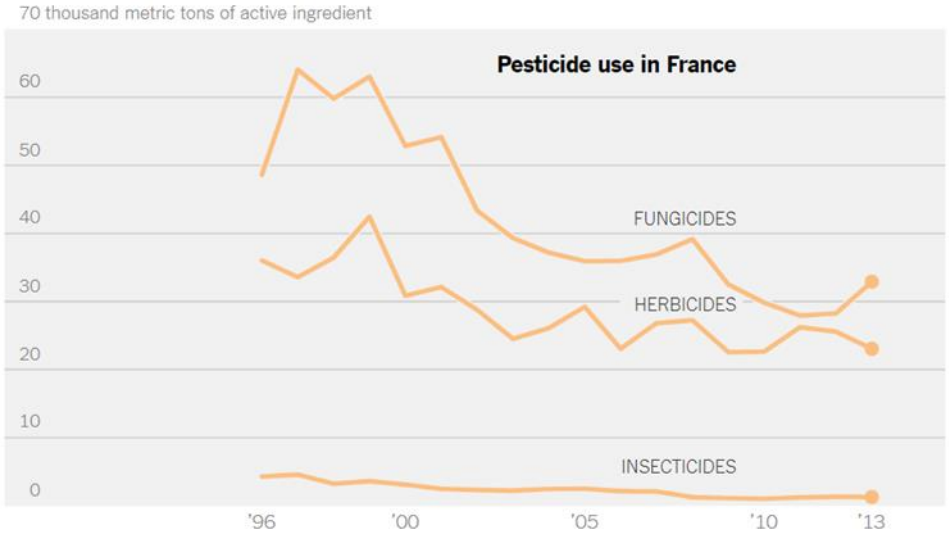
End of Question 27

Question 28 (4 Marks)

Many crop seed manufacturers have said that genetically modified crops would increase the yield per unit area of land and reduce the need for pesticides.
At the beginning of this century, the United States and Canada began introducing genetic modifications in agriculture. Europe did not utilise the technology. One example is the crop rapeseed (used for canola oil production). Below are the results of the rapeseed crop yield and pesticide use for North America compared to Western Europe and France in particular for pesticides, where genetically modified organisms (GMOs) are not permitted.



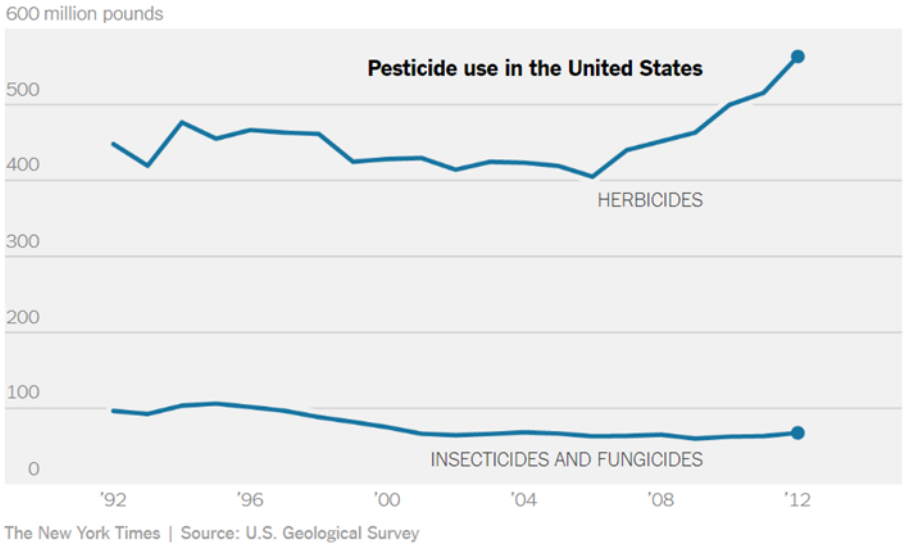
The New York Times | Sources: Food and Agriculture Organization of the United Nations | Note: Western Europe is France, Germany, Belgium, Luxembourg, Switzerland, the Netherlands and Austria.



The New York Times | Source: Union of Industries of Plant Protection (France)

Question 28 continues on page 25

Question 28 (continued)



(a) With reference to the graphs, support or refute the manufacturer's claims that using GMO crops increases yield and decreases the need for pesticides. **2**

……

……

……

……

……

……

(b) Why can't the information provided by the graphs be used to end the debate once and for that all, that we "need genetically modified crops to feed the entire world population"? **2**

……

……

……

……

……

……

Question 29 (9 marks)

(a) Discuss TWO components of public health campaigns and their intended functions in the campaign. **4**

……

……

……

……

……

……

……

……

(b) Justify the importance of non-infectious disease prevention and its research to our society. Use examples not used elsewhere in this paper to support your ideas. **3**

……

……

……

……

……

……

……

……

……

Question 29 continues on page 27

Question 29 (continued)



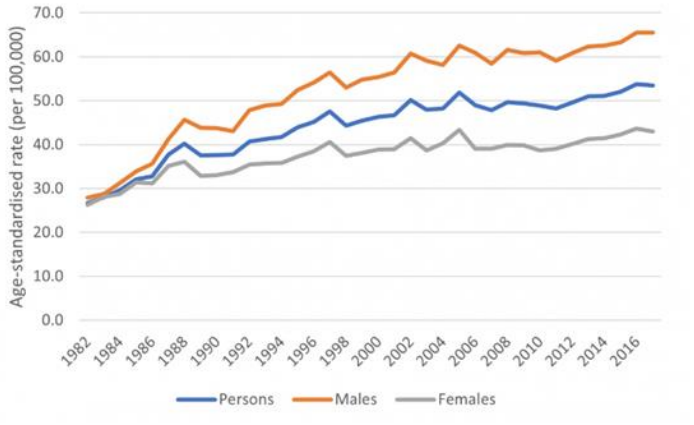


Figure 2. Age-standardised incidence rates for melanoma of the skin, 1982 to 2017, by sex

The "Sunsmart" website states:
"One of the most successful health campaigns in Australia's history was launched in 1981, when a cheerful seagull in board shorts, t-shirt and hat danced his way across our TV screens singing the jingle. Slip, Slop, Slap!"

(c) Discuss this statement with specific reference to the data provided. **2**

……

……

……

……

……

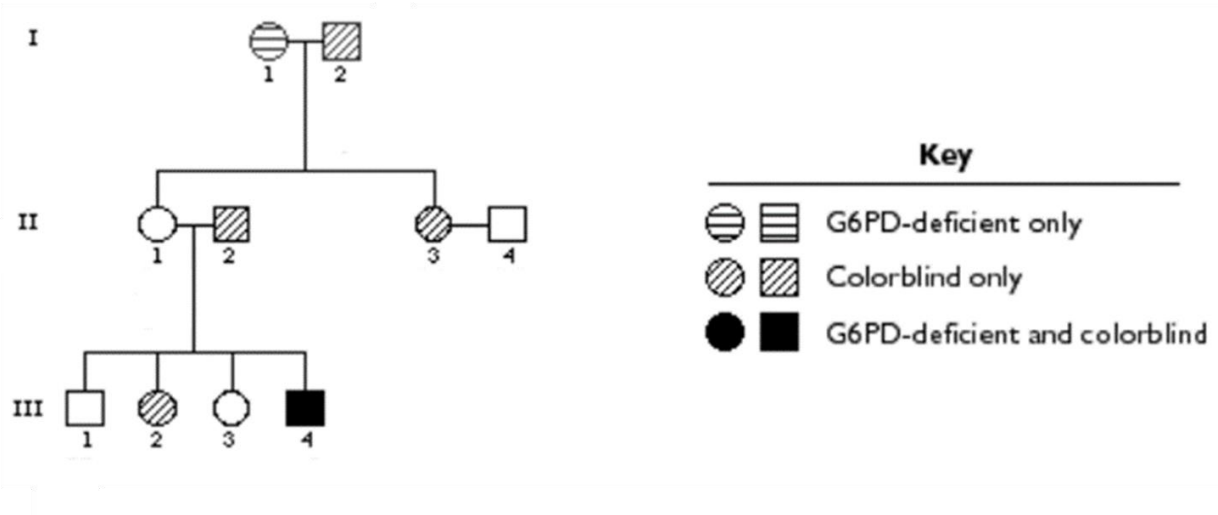
……

End of Question 29

Question 30 (6 Marks)

In humans, glucose-6-phosphate dehydrogenase (G6PD) deficiency and red-green colour-blindness are both X-linked recessive traits.

The pedigree chart below presents the inheritance of these traits in a family whose relationships have been confirmed by genetic testing.



Allele designations:
G = normal G6PD; g = G6PD-deficient
D = unaffected (normal vision); d = red-green colorblind

(a) For individuals II-1 and II-2, what is the expected genotypic ratio of their offspring. Show all working. **4**

……

……

……

……

……

……

……

……

Question 30 continue on page 29

Question 30 (continued)

(b) Account for the phenotypes of individuals III-1 and III-4. **2**

……

……

……

……

……

……

End of Question 30

Question 31 (7 Marks)

Lupin is a pulse crop produced for stock feed. *Colletotrichum lupini* is a fungal pathogen that causes severe disease in lupin.

The image overleaf summarises the significant known steps in interactions between some plants and fungi.

1. The plant defences prevent the penetration of the fungal hyphae by inducing change in the shape of cell wall (cell wall abnormality) and release of antifungal chemicals.

2. Pathogenic fungi release an array of cell wall-degrading, hydrolytic enzymes to fragment the plant cell wall polymers and use the carbon sources from the cell wall as a source of nutrition.

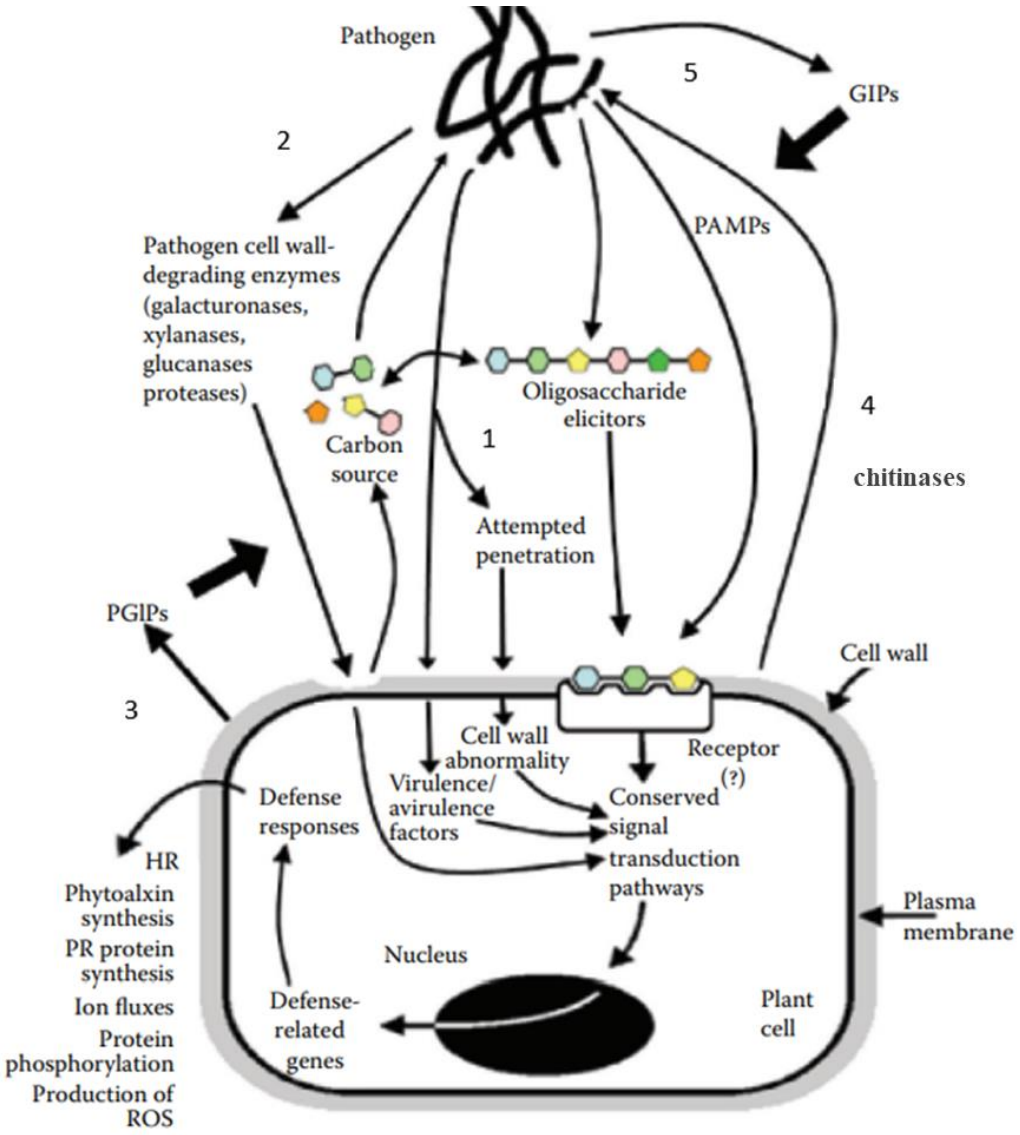
3. Plants release fungal glycanase inhibitors like polygalacturonase-inhibiting proteins (PGIPs) to reduce the catalytic activity of fungal glycanases.

4. PGIPs limit plant pathogens' growth and elicit 2 main plant defenses.
   (i) release of ion fluxes, ROS (reactive oxygen species) regulates cell differentiation and cell death etc.
   (ii) chitinases attack fungal cell wall.

5. In response, fungi produce glucanase inhibitor proteins (GIPs) that prevent degradation of their cell wall, thus limiting their attack by the plants. Once inside the host tissues the fungi form a specialised structure called an haustorium with a suspected role in nutrient uptake by increasing chitin deacetylase activity.

Chitin deacetylation on the surface of the penetration hypha has been suggested to protect the fungal cell wall from the action of plant chitinases.

Question 31 continues on page 31



(a) Describe ONE adaptation of the fungal pathogen that helps it survive in the host. **2**

……

……

……

……

(b) Outline a successful plant response to the infection. **2**

……

……

……

……

Question 31 continues on page 30

(c) Describe the processes by which fungi can reproduce. **3**

……

……

……

……

……

……

End of Question 31

Question 32 (5 Marks)

Assess the role of cell replication processes in ensuring the continuity of species. **5**

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Question 33 (20 marks)

Chicken pox, also called varicella, is a highly contagious disease caused by primary infection with the varicella zoster virus (VZV). About 14-16 days after exposure, an itchy rash may form on the skin, which is the characteristic symptom. Other symptoms include fever, sore throat and general malaise. Symptoms are more severe in older patients, but historically most people were infected during childhood. Re-infection with VZV does not generally cause symptoms, giving rise to the observation that people don't generally catch chicken pox more than once.

Patients are infectious a few days before the rash appears until it blisters over. The virus is spread through airborne routes and from exposure to fluid from the blisters.

The VZV virion is 120 nm in diameter and contains a linear DNA molecule of about 125, 000 base pairs. It can infect only humans and great apes.

(a) Not all viruses contain DNA, some contain only RNA.

Outline ONE significant benefit to a virus of having a genome composed of DNA. **2**

……

……

……

……

In the second half of the 20th Century, a varicella vaccine was developed based on a weakened strain of VZV.

(b) Identify a group of patients who should not be given a live vaccine and explain why it would not be appropriate for them. **2**

……

……

……

……

……

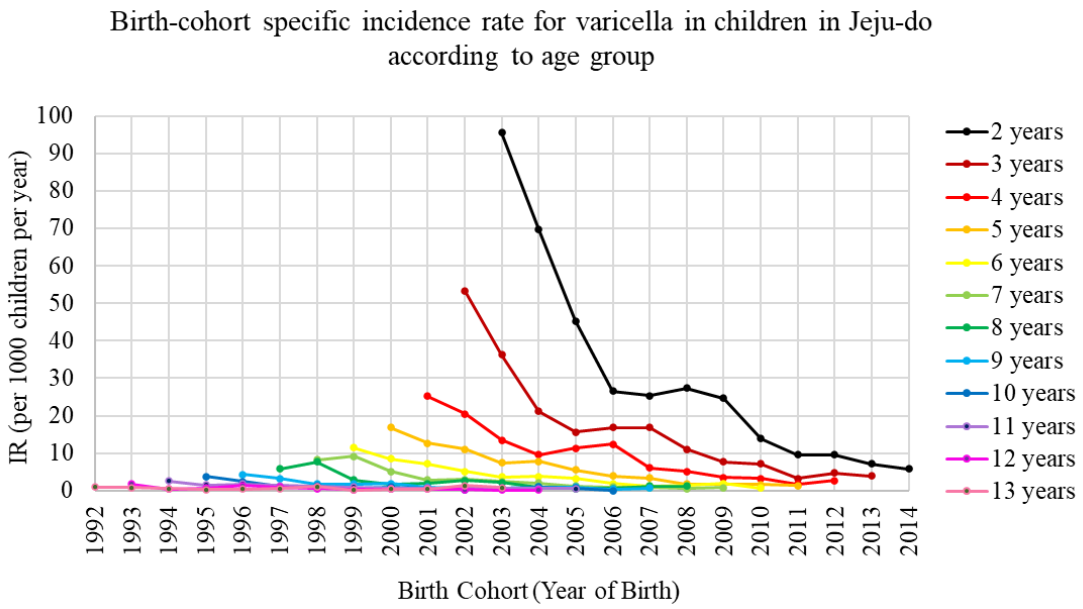
……

Question 33 continues on page 35

Question 33 (continued)

The vaccine is typically administered to patients in the 1-4 year age group. It is about 80% effective at preventing varicella infection, with immunity lasting more than 20 years in some patients and waning in less than six years in other patients. It is postulated that repeated exposures to the naturally occurring virus helps to maintain immunity.

A retrospective study was carried out in Jeju-do province, South Korea. Historical medical claims data for a 12 year period were analysed for suspected varicella in children aged 2-13 years. Data analysis was performed to calculate the incidence rate (IR) for contracting the disease at different ages for a range of birth cohorts (children born in the same year).



(c) From which calendar years were the data collected? **1**

……

……

(d) Describe the trends shown in the graph. **3**

……

……

……

……

……

……

Question 33 continues on page 36

Question 33 (continued)

In 2005 the varicella vaccine was added to the required vaccine schedule in South Korea for infants aged 12-15 months. In 2011, free, mandatory vaccination for varicella at 12-15 months of age was introduced in Jeju-do province.

(e) Explain whether there is any evidence supporting the effectiveness of these vaccination programs on the graph. **3**

……

……

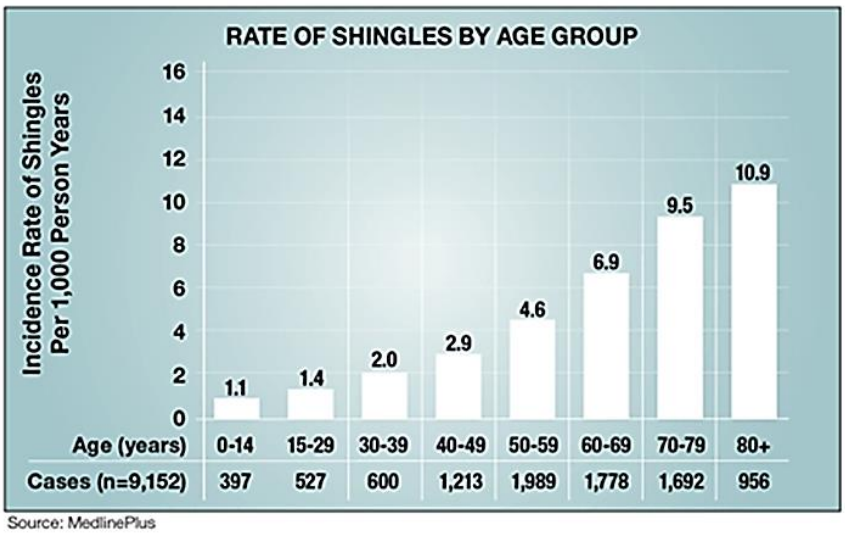
……

……

……

……

After the body has fought off the infection, either naturally occurring or from the vaccination, the virus typically lays dormant in the nervous system. It may become reactivated, resulting in a painful condition termed shingles, with infectious blisters forming in the skin above the affected nerves. Although the mechanism for reactivation of the virus is not known, any factor which weakens the immune system will potentially allow it to develop and cause shingles. This includes stress, diseases such as HIV/AIDS and cancer, as well as age, as shown in the diagram below:



Source: MedlinePlus

The likelihood of contracting shingles before turning 15 is 1.65% (1.1 x 15)/1000 x 100/1)

(f) What is the likelihood of an individual contracting shingles at any age prior to their 80th birthday? **1**

……

Question 33 continues on page 37

Question 33 (continued)

(g) A knowledge of biology can lead to treatments and technologies with the potential to reduce the suffering in the community resulting from shingles in both immediately and in decades to come.

Evaluate this statement with reference to at least THREE distinct treatments and/or technologies which have not been mentioned in earlier parts of this question. **8**

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Question 33 continues on page 38

……

……

……

……

……

……

……

……

……

……

……

……

……

End of Exam

Section II extra writing space
If you use this space, clearly indicate which question you are answering.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Section II extra writing space
If you use this space, clearly indicate which question you are answering.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Section II extra writing space
If you use this space, clearly indicate which question you are answering.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……