H

CATHOLIC JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS
Higher 1

Answers

CANDIDATE NAME					
CLASS	**2T**	**INDEX NUMBER**			

BIOLOGY

8875/02
23rd August 2016
2 hours

Additional Materials: Writing Paper

READ THESE INSTRUCTIONS FIRST

Write your index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper. **[PILOT FRIXION ERASABLE PENS ARE NOT ALLOWED]**
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

There are two sections in this paper.

Section A]
Answer all questions

Section B]
Answer one questions. Answer each part on a **separate** piece of paper.

At the end of the examination, fasten all work securely together.
The number of marks is given in brackets [ ] at the end of each question or part of the question.

For Examiner's Use	
Section A	/40
1 [8]	
2 [11]	
3 [10]	
4 [11]	
Section B	/20
5 or 6	
TOTAL	/60

Section A

Answer **all** questions in this section.

1 Cells were transferred and grown in ^{15}N medium for many generations before they were transferred to ^{14}N medium again and allowed to divide.

DNA was extracted periodically from the culture and subjected to density gradient centrifugation using caesium chloride.

Fig. 1.1 shows the density gradient results across three generations.

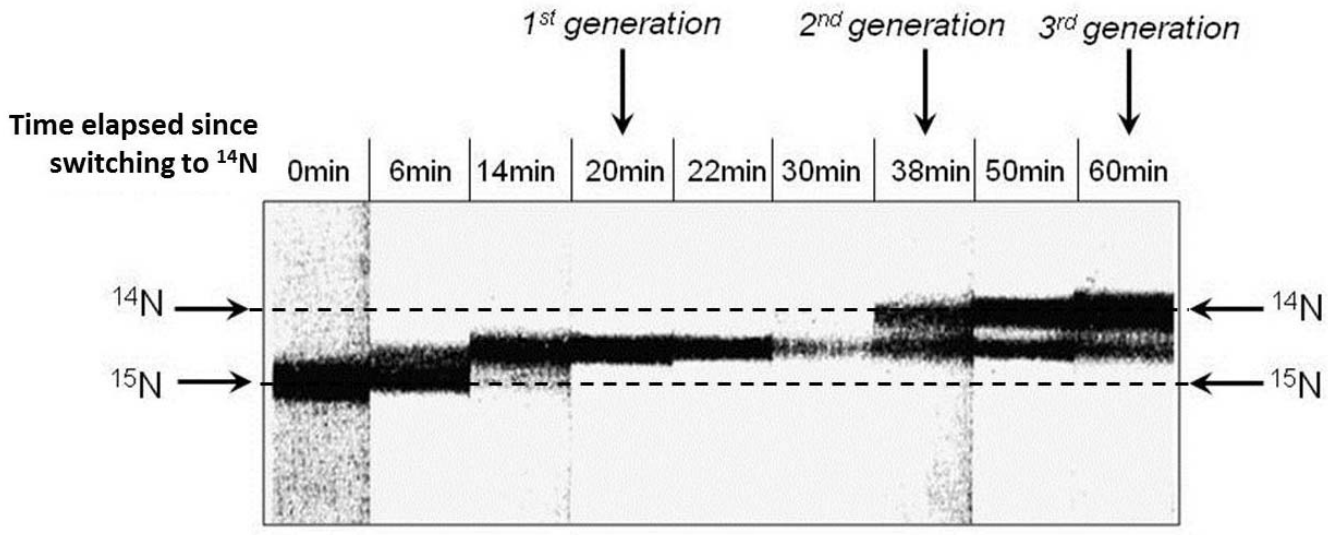


Fig. 1.1

(a) With reference to Fig. 1.1, account for the model of DNA replication which these cells undergo.

……

……

……

……...[3]

S: Account (CW), with reference..Fig. 1.1, model..DNA replication, cells…undergo,

C:

- With reference Fig. 1.1 → Must cite information from Fig. 1.1 in answers
- There are 3 models of DNA replication: Semi-conservative, conservative, dispersive
- Model here is semi-conservative
  - 1 intermediate band at 1st generation
  - 2 intermediate band, 2 bands at 2nd generation, 2 bands at 3rd generation with intermediate band becoming thinner and light band becoming thicker.

ORE:

1. The model of DNA replication is **semi-conservative.**
2. At the **first generation**, there is only **one** **$^{14}N/^{15}N$** / hybrid **band**, which suggests the **parental strands**, that **contain ^{15}N separate** to serve as **template** for the synthesis of the **newly synthesised strand,** which **contains ^{14}N**.
3. At the **second generation**, there is **one** **$^{14}N/^{15}N$** / hybrid **band** and **1 light band** which aligns with the semi-conservative model of replication as the former contains DNA with **1 strand**

containing ^{15}N and another containing ^{14}N, whereas the latter contains DNA with **both strands containing ^{14}N**.

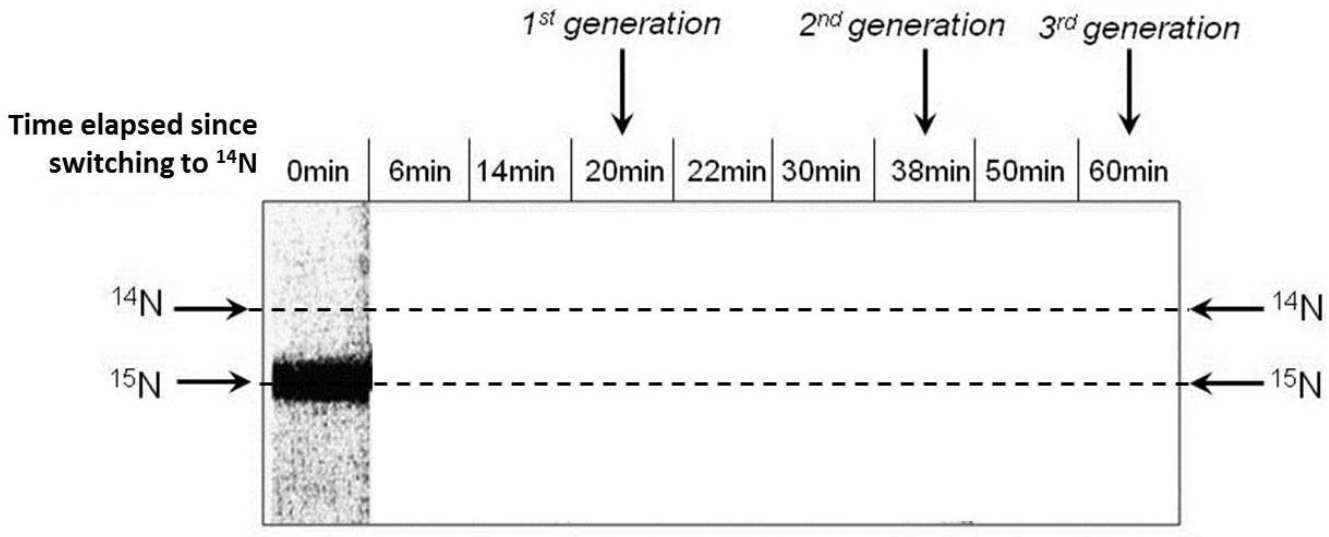
4. For the **third generation**, there is still **one $^{14}N/^{15}N$** / hybrid **band** and **1 $^{14}N/^{14}N$ band** and the intermediate band becomes thinner whereas the light band becomes thicker due to **more DNA** molecules containing **^{14}N on both strands**.

(Max 3)

[L2]

(b) State another model of DNA replication not shown in Fig. 1.1 draw only its band patterns for the 1st, 2nd and 3rd generations in the Figure below.

Model of DNA replication: ……



[2]

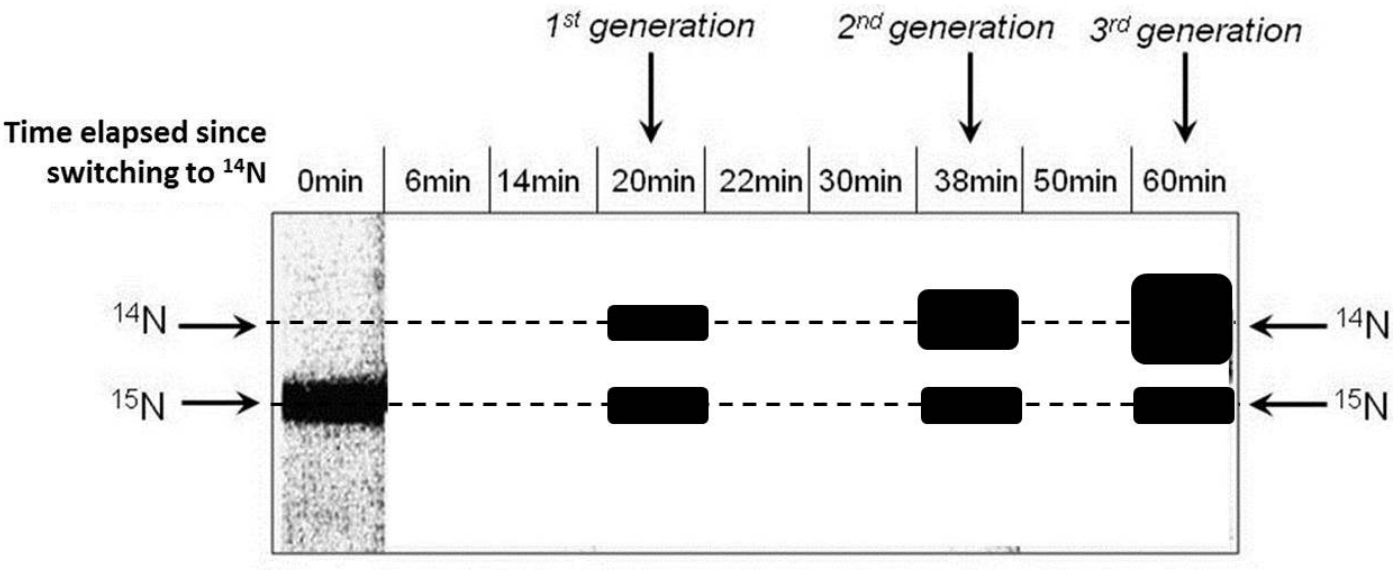
S: State….Draw (CW), model of DNA replication, not shown in Fig. 1.1, draw..band patterns..1st,2nd,3rd,

C:

- Model of DNA replication shown in Fig. 3.1: Semi-conservative
- Other models: Conservative & Dispersive

ORE:

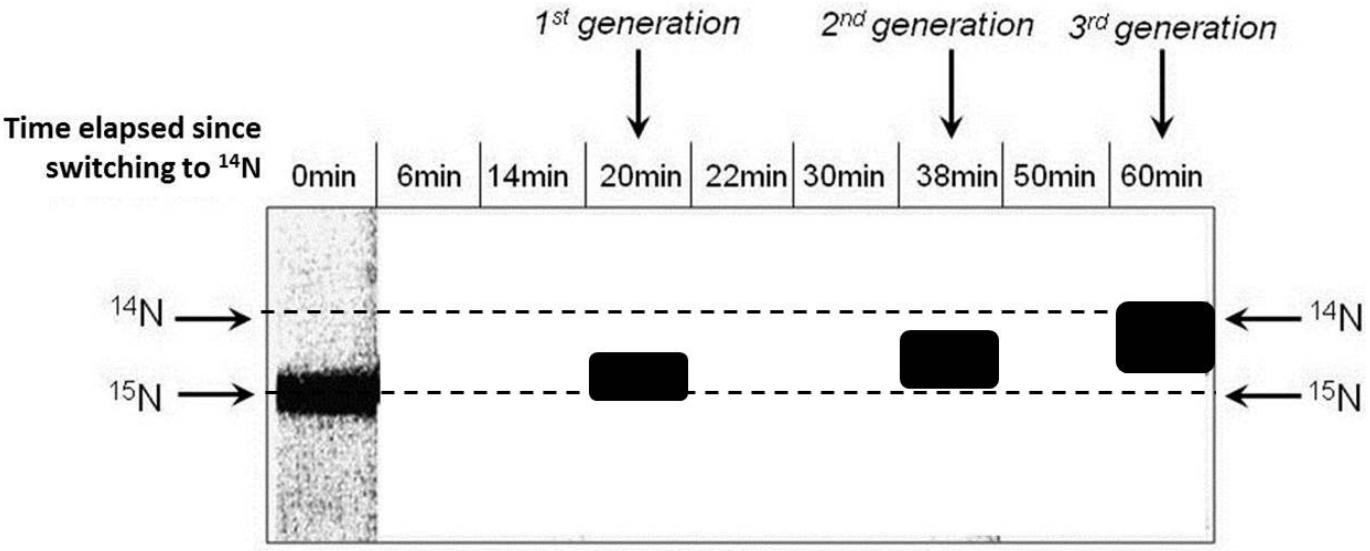
- Model of DNA replication: **Conservative** replication



[1 mark for correct positioning of the bands]
[1 mark for correct amount of DNA as shown by thickness of band or shade of band]

OR

ORE:
- Model of DNA replication: **Dispersive** replication [1 mark]



[1 mark for correct positioning of the bands]
[1 mark for correct amount of DNA as shown by thickness of band or shade of band]

[L2]

DNA replication has many similarities with translation even though the products formed are different. Some of the similarities are that they both take place in 3 different stages (initiation, elongation, termination), both require energy, monomers for extension, a template for product synthesis as well as bond formation involving the removal of a water molecule.

(c) State three other similarities between the cellular process shown in Fig. 1.1 and translation.

……

……

……

……..[3]

S: State (CW), DNA replication & translation, other similarities

C:

- Similarities between DNA replication & Translation
- Other similarities: Cannot mention both require energy, monomers for extension, a template for product synthesis as well as bond formation involving the removal of a water molecule

ORE:

1. Both processes require **enzymes** (DNA replication: DNA polymerase & Translation: Peptidyl transferase).
2. Both processes involve **complementary base pairing**.
3. Both processes are **regulated** by regulatory **factors** (DNA replication: cyclins, CDKs, Helicase & Translation: translational regulatory proteins).
4. Both processes are **compartmentalised** in the **cell** (DNA replication: nucleus, Translation: ribosome).
5. **Errors** can occur for both processes.
6. Both processes **only occur** when **required** by the cell.

[L3]

[Total: 8]

2 Fig. 2.1 shows a Calico cat with a mosaic coat with patches of orange and black. It is known that fur coat colour in cats is determined by a single gene. Only female cats can develop calico fur coat. Male cats usually have only orange or black fur coat.

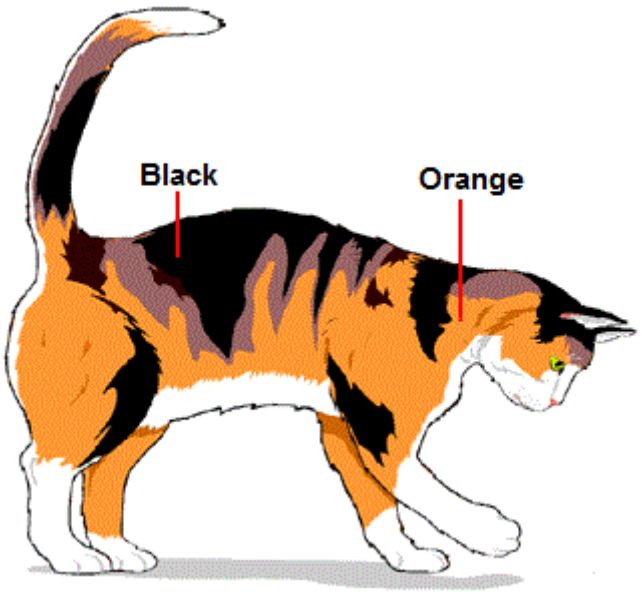


Fig. 2.1

(a) Identify the type(s) of inheritance determining calico fur coat colour in cats. [1]

[L2] – Scaffolded in CA5 Qn 1

S: State (CWs), type of inheritance, fur coat colour
C:
- Calico (patches of black and orange) → both equally expressed → codominance/epistasis.
- Difference between male and female → possible sex-linked.
- Inheritance determined by single gene → confirm codominance (cannot be epistasis)

ORE:

1. **Co-dominance**
2. **Sex-linked / X-linked**

(b) Using B to represent allele for black coat and R to represent allele for orange coat, draw a genetic diagram to show how a cat-breeder can obtain calico cat from a cross between a pure-breeding black male and an orange female cat. [5]

[L2]

S: Draw (CWs), genetic diagram, orange female x black male,
C:
- Sex-linked & codominant (X^B & X^R alleles)
- Orange female X^RX^R
- Black male X^BY

ORE:

Let **X^B represent the allele for black coat colour**.
Let **X^R represent the allele for orange coat colour**, where **X^B and X^R** are **codominant**. **[1]**

Parental phenotypes : Orange Female x Black Male

Parental genotypes (2n): $X^R X^R$ x $X^B Y$ **[1]**

Parental gametes (n): X^R x X^B Y **[1]**

F_1 genotypes and phenotypes (2n):

♀ \ ♂	X^B	Y
X^R	X^BX^R Calico coat	X^R Y Orange coat

[1]

F_1 phenotypic ratio: **1 Calico female: 1 Orange male** **[1]**

Tay–Sachs disease is an autosomal recessive disease which causes a progressive deterioration of nerve cells, mental and physical abilities in patients. This disease is caused by a mutation in the hexA gene found on chromosome 15, which codes for the alpha-subunit of hexosaminidase A, a lysosomal enzyme.

A man who is heterozygous at the locus for the blood type B antigen has a son with a woman with blood type O. Both parents are carriers for Tay-Sachs disease. Blood blood types are determined by genes on chromosome 9.

(c) Draw a genetic diagram to determine the possible phenotypes of their child. [5]

[L2]

S: Draw (CWs), genetic diagram, possible phenotypes of offspring,
C:
- Dihybrid inheritance (independent assortment of alleles for unlinked genes)
- Father I^BI^O Tt
- Mother I^OI^O Tt

ORE:

Let **I^B represent the dominant allele for type B antigen**.
Let **I^O represent the recessive allele for production of neither antigen**.
Let **T represent the dominant allele that codes for lysosomal enzyme hexosaminidase A**
Let **t represent the recessive allele that does not produce lysosomal enzyme** **[1]**

Parental phenotypes: Blood Group B, Tay Sachs Carrier x Blood Group O, Tay Sachs Carrier

Parental genotypes (2n): I^BI^O Tt x I^OI^O Tt **[1]**

Parental gametes (n): I^BT I^Bt I^OT I^Ot x I^OT I^Ot **[1]**

Genotypes and phenotypes of offspring (2n):

♂ \ ♀	I^OT	I^Ot
I^BT	I^BI^O TT Bld Grp B, Normal	I^BI^O Tt Bld Grp B, Normal
I^Bt	I^BI^O Tt Bld Grp B, Normal	I^BI^O tt Bld Grp B, Tay Sachs
I^OT	I^OI^O TT Bld Grp O, Normal	I^OI^O Tt Bld Grp O, Normal
I^Ot	I^OI^O Tt Bld Grp O, Normal	I^OI^O tt Bld Grp B, Tay Sachs

[1]

F_1 phenotypic ratio:
3 Normal Blood Grp B: 1 Tay Sachs Blood Grp B: 3 Normal Blood Grp O: 1 Tay Sachs Blood Grp O **[1]**

[Total: 11]

3 The Grand Canyon National Park is home to two groups of squirrels. The Albert squirrels *Sciurus aberti* live generally on the south rim of the canyon and the Kaibab squirrels *Sciurus kaibabensis* live on the north rim of the canyon (Fig. 8.1 and Fig. 8.2).

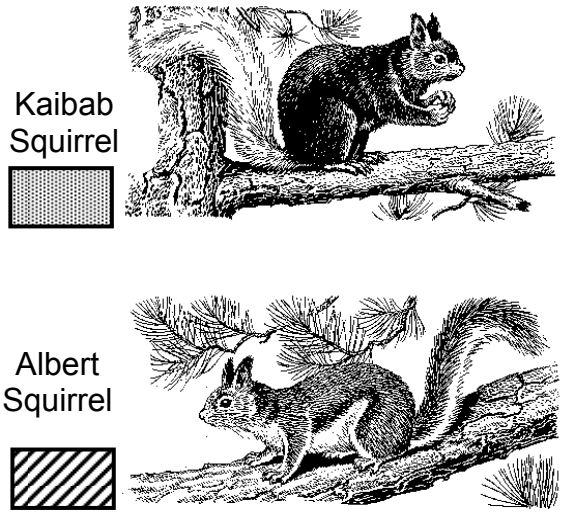


Fig. 8.1

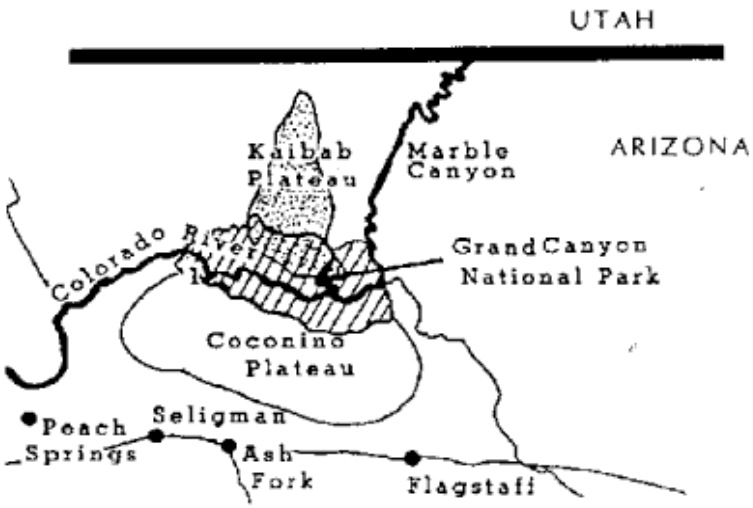


Fig. 8.2

The north rim is about 370 m higher than the south rim. Almost twice as much precipitation falls on the north rim than on the south rim every year. The two groups share many characteristics, but they do not look the same, both groups have tasselled ears, but each group has a unique fur colour pattern.

(a) Explain which Darwinian principles can be applied from the above information on *S. alberti* and *S. kaibabensis*.

……

……

……

……

……[4]

SC: which Darwin Principles / squirrels
OR: 1. High reproductive potential- great range
2. Competition / struggle to survive – no information
3. Constant population- great range seen in both groups.
4. Variation- Seen from the different phenotypic characteristics.
5. Selection pressure – environment on either side of canyon.precipitation
6. Passed down to next generation- phenotypical characteristics.

1. **High reproductive potential** inferred from the wide distribution of both groups in Fig. 8.2
2. **Constant population** inferred from the wide distribution of both groups in Fig. 8.2
3. **Variation** can be inferred from the **different phenotypic characteristics of the squirrels.**
4. **Selection Pressure** inferred from the environmental conditions on either side of the canyon, reference to precipitation being twice greater in the north compared to the south.
5. **Passed down to the next generation**- phenotypical characteristics of each group.

[L2]

Several studies have been done on the phylogenetic relationship of the squirrels in and around the Grand Canyon region. Fig. 8.3 is one such study based on cytochrome b DNA sequences.

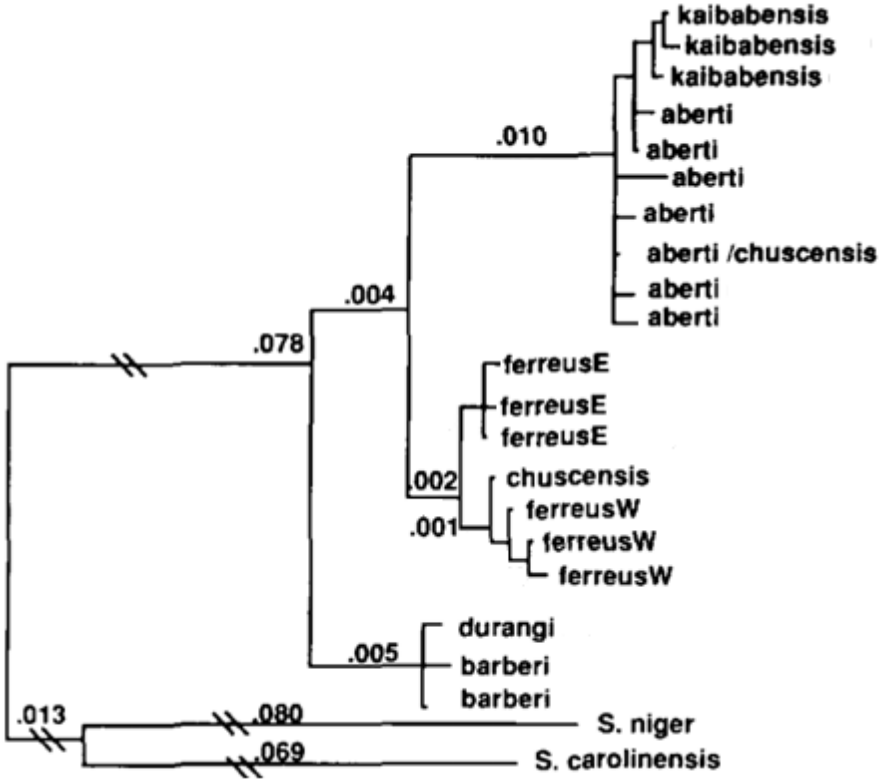


Fig.8.3 Phylogenetic relationship between six *sciurus* subspecies base on cytochrome b sequences constructed by the neighbour-joining method of Saitou and Nei (1987) using the *S. niger* and *S. carolinesis* (Thomas and Martin 1993) sequences as outgroups. Branch lengths and confidence probabilities are noted above and below the branches respectively.

(b) With reference to information already given and also to Fig. 8.3, it is clear that divergent evolution or adaptive radiation is occurring in the evolution of *S. alberti* and *S. kaibabensis*

Explain why it is not convergent evolution.

……

……

……..[2]

SC: kind of evo- not divergent / adaptive rad. / why not convergent evo
OR: 1. common ancestor
2. subspecies
Reject morphological homology

1. share a recent **common ancestor**
2. **convergent evolution** involves **two phylogenetically different groups** with no recent common ancestor.

Or any one of the following-

3. **homology of DNA** sequence for cytochrome b shows **high relation 0.01**
4. **they are subspecies**

(Max 2)

[L2]

(c) With reference to information in Fig. 8.2 and Fig. 8.3, explain how natural selection contributes toward evolution of the two species of squirrel.

……

……

……..[4]

SC: Explain (CW) natural selection → evolution
OR: 1. There is **pre-existing variations** within the **ancestral species** of squirrels.
2. **Natural selection** of squirrels **best suited** for the given environment.
3. **Selection pressure in the north and south rim** of the Grand Canyon National Park **differs**,
4. **squirrels with advantages traits / alleles** survive to reproduce, **passing on their alleles to offspring**.
5. Over time, **allele frequency of the two populations** become **increasingly distinct**
6. **Two populations cannot interbreed**, resulting in two species.

[L2]

[Total: 10]

4 Human Growth Hormone is important to augment normal growth and development in the treatment of individuals with dwarfism. Fig. 4.1 shows how human growth hormone can be produced via expression of recombinant DNA in *Escherichia coli* host cells.

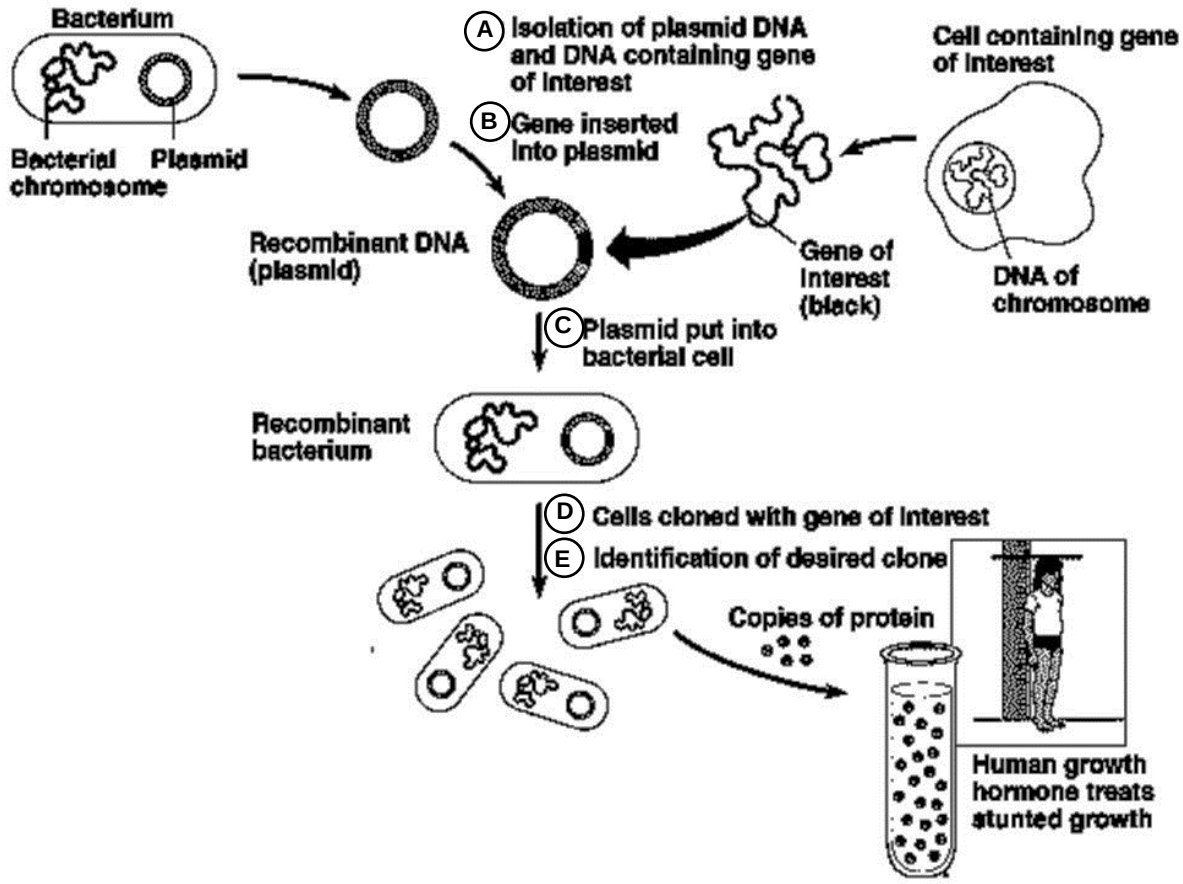


Fig. 4.1

(a) Explain what is meant by recombinant DNA.

……

……[1]

1. **Genes from two different sources / organisms** are **combined** *in vitro* into a single plasmid **/ OWTTE** (accept contextual answers).

[L1]

(b) Name the process required in the following procedure in Fig 4.1.

C : ……**Transformation**

E : ……**Selection / Screening**

[1]

(Both correct – 1 mark)

[L1]

(c) The gene of interest cannot be taken directly from DNA of chromosome but require additional processing in order to produce functional protein.

(i) With reference to Fig. 4.1, explain why the gene of interest cannot be taken directly from chromosomal DNA.

……

……

……[2]

1. **Eukaryotic DNA** contains **introns** and
2. **bacterial** / **prokaryotic** host cells **do not have post-transcriptional modification / splicing to remove introns.**
3. **Non-functional protein may be synthesized** if introns are not removed.

(Max 2)

[L1]

(ii) Outline the additional processing required to yield the gene of interest prior to insertion into the plasmid.

……

……

……

……[3]

1. **Isolate the processed / mature mRNA** coding for human Growth Hormone
2. Use **reverse transcriptase** to **synthesize single-stranded cDNA** using the processed mRNA as template **(Reject: conversion)**
3. Use **DNA polymerase** to replicate the **single-stranded cDNA into double-stranded cDNA**.
4. **Addition of linker DNA** to the **ends** of the double stranded cDNA / Gene of interest.

(Max 3)

[L2]

(d) State one possible pair of gene markers present on the cloning site of the plasmid for the identification of desired clone in Fig. 4.1.

……

……

……[1]

1. **Ampicillin resistance gene** & **Tetracycline resistance gene**

   OR

2. **LacZ gene / β-galactosidase gene** & **Ampicillin resistance gene**

(Max 1)

[L2]

(e) Outline the process for Stage E in Fig 4.1 using one of the gene markers in (d).

……

……

……

……[3]

1. **Replica-plate** the **master plate containing the bacterial clones** on two separate **agar plates containing ampicillin and tetracycline**.
2. **Bacterial clones / colonies** that grow on both antibiotic plates are **resistant to both antibiotics are non-recombinant**.
3. **Select for bacterial clones sensitive to the antibiotic of the gene marker in (d)** but **resistant to the other antibiotic** from the **master plate**.
4. Correct reference to **insertional inactivation**.

(Max 3)

OR

1. **Culture the bacterial clones / colonies** on **X-gal** medium with ampicllin.
2. **Bacterial clones / colonies** that appear **blue** are **non-recombinant** as LacZ gene is intact.
3. **Select for white bacterial clones** that are **recombinant**.
4. **LacZ gene is disrupted** due to **insertional inactivation**.

(Max 3)

[L2]

[Total: 11]

Section B

Answer **One** questions. Answer each part on a **separate** piece of paper.

Write your answers on separate answer paper provided.
Your answer should be illustrated by large, clearly labelled diagrams, where appropriate.
Your answer must be in continuous prose, where appropriate.
Your answer must be set out in sections **(a)**, **(b)** etc., as indicated in the question.

5 **(a)** Describe the process of mitosis and its importance. [6]

S: Describe (CW), process & importance of Mitosis **[L1]**

C: Process
- Prophase, Metaphase, Anaphase and Telophase

Importance
- Maintains genetic stability to produce genetically identical nuclei
- Increase number of cells for growth
- Asexual reproduction
- Replace damaged cell and regeneration

ORE:
Process [Max 4]:

1. **Prophase**: **Chromatin condenses to chromosome / sister chromatids joined at centromere; centrioles migrate to opposite poles; mitotic spindles begin to form; nuclear envelope disintegrates; nucleolus disappears** [Any 3 – 1m]

2. **Metaphase: Centrioles reached opposite poles; Spindle fibres attached to kinetochore; chromosomes align on metaphase plate; nuclear envelope and nucleolus absent** [Any 2 - 1m]

3. **Anaphase: centromeres divide/separate; sister chromatids moves to opposite poles; shortening of kinetochore microtubules/spindle fibres**; [Any 2 – 1m]

4. **Telophase: chromosomes reached opposite poles; chromosomes uncoiled to chromatin fibers; spindle fibers disintegrates; nuclear envelope reforms; nucleoli reappears, forms two** genetically identical **daughter nuclei** [Any 3 – 1m]

Importance [Max 2]:

5. Maintains **genetic stability** to produce **genetically identical** nuclei

6. **Increase number of cells** for **growth**

7. **Asexual reproduction**

8. **Replace damaged cell** and **regeneration**

Reject: Citation of interphase and cytokinesis as these stages occur prior and after mitosis.

(b) Outline the process of chemiosmosis during photosynthesis and respiration. [4]

[L1]
S: Outline (CWs), Chemiosmosis, photosynthesis, respiration
C:
- Chemiosmosis (energy from ETC, pump H+, proton reservoirs, proton gradient, diffusion, ATP synthase for ATP synthesis)
- Photosynthesis (in chloroplast), respiration (in mitochondrion)

ORE:

1. **Energy released** as electrons are passed down **electron transport chain**
2. Used to **pump protons/H+** into reservoir to form **proton gradient**
3. Reservoirs: **Thylakoid space (photosynthesis)** and **mitochondrial intermembrane space (respiration)**
4. **Proton motive force / protons / H+ diffuse down concentration gradient**
5. and pass through membrane associated **ATP synthase / stalked particles** for **ATP synthesis**
6. **Proton / H+** returns **back to stroma (photosynthesis)** and **back to matrix (respiration)**

[Max 4]

(c) The enzyme catalase is found in potatoes. This enzyme catalyses the breakdown of hydrogen peroxide to water and oxygen.

Describe an investigation into the effect of temperature on the activity of catalase in potatoes, by measuring the release of oxygen. [10]

[L3]

S: Describe (CW), investigation (experiment), effect of temperature on catalase activity by measuring release of oxygen (product); substrate (hydrogen peroxide)

C:
- Independent variable: temperature / °C
- Dependent variable: activity of catalase measured by volume of oxygen produced / cm^3
- Constant variables:
  - mass of potato / volume of enzyme
  - time period for measurement of product
  - pH

ORE:

Aim: Investigation into effect of temperature on activity of potato catalases on breakdown of hydrogen peroxide to water and oxygen

Hypothesis [Max 2]:
1. Enzymatic activity should increase with increasing temperature / ref. to Q10 principle
2. Potato catalase enzyme has an optimal temperature that has a highest rate of product formation (volume of oxygen gas produced measured),
3. Beyond optimal pH (higher or lower), the volume of oxygen gas produced per unit time will decreased.

Introduction [Max 2]:
4. Temperature increase kinetic enzyme of enzyme and substrate molecules, increasing chances for effective collision to form enzyme-substrate complexes.

5. Beyond optimal temperature, the bonds within the tertiary structure of the enzyme may break resulting in the loss of specific 3D conformation of the enzyme active site, decreasing the rate of enzymatic activity.
6. At very high temperature, enzyme may be denatured.

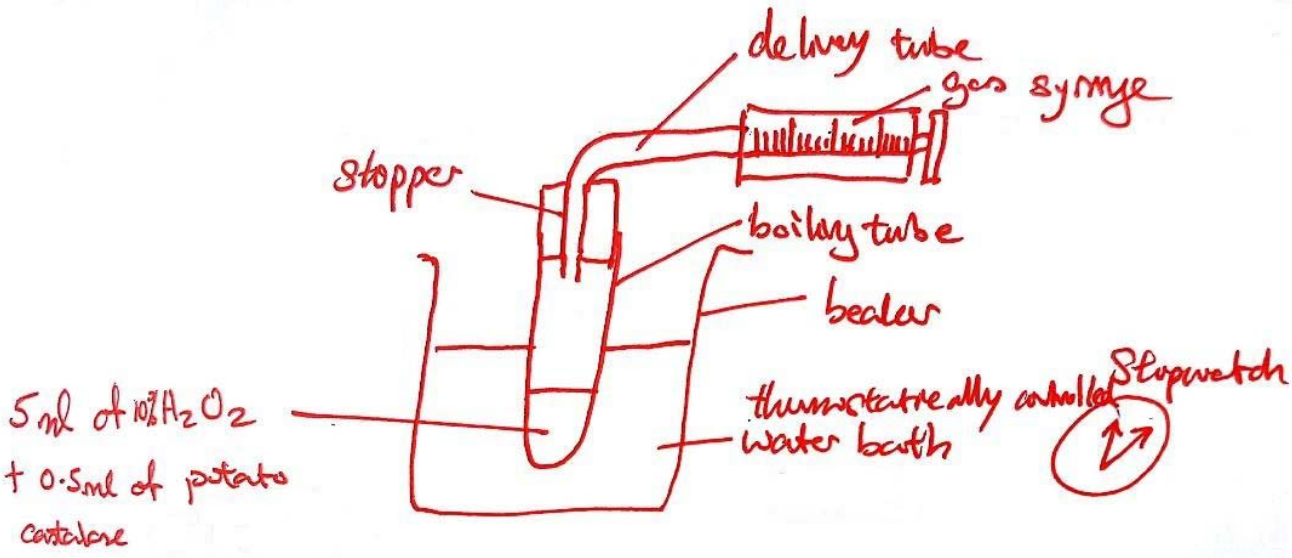
Variables [Max 1]:

7. Independent variables – temperature (10°C, 20°C, 30°C, 40°C, 50°C) – Accept AVP
   Dependent variables – Volume of oxygen gas produced per min / cm^3

8. Constant variables:
   - mass of potato / volume of enzyme
   - volume and concentration of hydrogen peroxide
   - time period for measurement of product
   - pH

Apparatus [1]:

9. Apparatus: See diagram (Award 1 mark for clear labelled set-up diagram, accept displacement method using inverted measuring cylinder)



Procedure [Max 4]:

10. Add fixed volume (5ml) of H_2O_2 to each of the 5 boiling tube labelled temperature (10°C, 20°C, 30°C, 40°C, 50°C)
11. Adjust thermostatically controlled water bath / water bath adjusted by ice and warm water to required temperature.
12. Add fixed volume (0.5 ml) of the potato catalase to the boiling tube labelled 10°C
13. allow to stand for 30s (equibration step).
14. After 30s, fit the stopper with the delivery tube attached to the gas syringe.
15. Start timing on stopwatch for fixed time (1 min) and measure the volume of oxygen gas produced after fixed time (1 min)
16. Record in a table of observation
17. Repeat the above steps 10 to 16 for the other four boiling tubes at temperature 20°C, 30°C, 40°C and 50°C.
18. Setup a negative control boiling tube that replaced potato catalase with buffer (accept other valid negative control). There should not be any production of oxygen gas for negative control.

Safety [Max 1]:

19. H_2O_2 is corrosive, wear googles, protective clothing and gloves during experiment.
20. Exercise caution when dealing with hot water to avoid scalding/burn.

Results [Max 2]:

21. Tabulate the results as shown below

Temperature /°C	Volume of oxygen gas collected per min / cm^3			
	Replicate 1	Replicate 2	Replicate 3	Average
10°C				
20°C				
30°C				
40°C				
50°C				

22. Plot the average volume of oxygen produced (dependent variable) on the y-axis of the graph against X axis of temperature (independent variable)

Interpretation [1]:

23. According to the graph, there should be a pH value at which the rate of production of oxygen gas is the highest, this would be the optimal pH for potato catalase. Beyond the optimal pH, the rate of production of oxygen gas should be lower / Cite Trend

[Max 10]

6 **(a)** Using appropriate examples, explain how the unique features of stem cells contribute to their functions in a living organism. [10]

[L2]

S: Explain (CW), using appropriate examples, features – functions of stem cells.

C:
- Undifferentiated
- Replicate indefinitely
- Telomerase activation
- Respond to signals for differentiation
- Developmental potential (Totipotent, Pluripotent and Multipotent)
- Examples: embryonic stem cells, neural stem cells, haematopoietic stem cells, epidermal stem cells etc.

ORE:

Features (stem cells): [Max 4]
1. **undifferentiated so that can differentiate under appropriate signals;**
2. **replicate indefinitely for self-renewal;**
3. **ensure a constant pool of stem cells;**
4. **telomerase activated;**
5. **respond to appropriate molecular signals;**
6. **developmental potential – Totipotent, pluripotent and multi-potent;**

Examples: [Max 6]
7. **embryonic stem cells are pluripotent – develop into all cell types but not a whole organism/except the extraembryonic tissues**
8. **divide for growth in mass/size/number of cells in developing embryo;**
9. **differentiate to form different tissues and organs**

10. **central nervous system/neural stem cells are multipotent; differentiated into neurons and glial cells/oligodendrocytes etc**

11. **hematopoietic/bone marrow stem cells are multipotent; differentiate into red blood cells/white blood cells/lymphocytes/platelet-forming cells etc.**

12. **epidermal (skin) stem cells are multipotent; differentiate to replace shed/damaged cells/keratinocytes / differentiate into hair follicles, glands etc**

13. **epithelium of intestine; replace digested/shed cells;differentiate into Paneth cells, goblet cells, absorptive cells etc (any 2 egs)**

14. **AVP**

Reject: generic answers pertaining to repair, replace, differentiate without specific examples

(b) Discuss the pros and cons of genetically-modified crop plants. [10]

SC	OR	E
CW: Discuss QKW: pros & cons, genetically-modified crop plants PRO	• Crop yield increase	1. Genetic engineering on plants can **enhance crop yields**.
PRO	• May bypass seasonal restrictions	2. Genetic engineering may permit crops to **grow outside** their **usual location** / **season** so that people have **more food**.
PRO	• Enhance nutritional content	3. Genetically modified crop plants can also be **enhanced** with a certain **nutritional content** (e.g. Golden rice) so that people are **better fed/OWTTE**.
PRO	• Pest-resistant crops	4. Genetically modified crop plants can be more **pest-resistant** (e.g BT corn),
PRO	• Lower cost	5. and this will **lower cost** as **pesticide** usage will be **reduced/avoided**.
PRO	• Less pollution	6. As pesticide usage is reduced/avoided, there will be **less damage/pollution** to the **environment**.
PRO	• Drought-resistance	7. Genetically modified crop plants can be more **drought-resistant**, and this will increase crop yield for farmers.
PRO	• Avoid costly irrigation	8. Drought-resistant crops can also help farmers **avoid** installing **costly irrigation** systems to ensure sufficient water is provided.
PRO	• Profits increase → consumer cost drops	9. As farmers' cost is reduced, their **profits increase** / **consumer cost** may also **reduce**.
PRO	• Increased shelf-life	10. **Shelf-life** of **crops** can be **increased** **Flavor Savr PG gene** example must be given
CON	• More invasive plants • Superweeds	11. The introduced gene(s) may be **transferred by pollen** to **wild relatives** whose hybrid offspring will become more **invasive** and hence become **'superweeds'**.

CON	• Cost involved in removing superweeds	12. This may lead to **additional cost for** the **removal** of such **'superweeds'.**
CON	• Plant diversity compromised	13. 'Superweeds' may also **reduce plant biodiversity** by **out-competing** natural plants
CON	• Organic farms may be compromised	14. The introduced gene(s) may be **transferred by pollen** to **unmodified plants** growing on a farm with **'organic'** certification, hence losing organic certification.
CON	• Toxic components	15. The modified plants will be a direct hazard to humans, domestic **animals** or other beneficial animals by being **toxic.** OR For instance, the herbicides that can now be used on the crop will itself **leave toxic residues** in the crop, which will be toxic to humans who consume them. OR **Disrupt ecological systems** e.g. Monarch Butterflies affected by BT.
CON	• Damage environment	16. The toxic residues/ overused pesticide may also affect and cause **unintended damage** to the **environment** by causing pollution to the surroundings.
CON	• Allergies	17. The modified plants will be a direct hazard to humans, domestic animals or other beneficial animals by being **producing allergies** upon consumption.
CON	• Farmers pay royalties	18. Farmers may have to **pay royalties** to sow the crops. OR 18. Some companies have extended their **patents on genetically engineered seeds** to prevent farmers from re-sowing the seed from these genetically engineered crops.
CON	• Higher consumer cost	19. The cost that farmers have to pay for the royalties may be passed on the **consumers** who may have to **pay higher prices** for them.
CON	• Vulnerability to diseases	20. **Genetically identical** and would be **equally vulnerable to disease.**

(Max 10, Maximum 5 pros and 5 cons)

[L2]

END OF PAPER