Diploma Programme
Programme du diplôme
Programa del Diploma

Biology
Higher level
Paper 2

12 May 2026
Zone A morning | **Zone B** morning | **Zone C** morning

Session number

2 hours 30 minutes

Instructions to c
- Write your
- Do not op
- Section A:
- Section B:
- Answers mus
- A calculator is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.

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20EP01

Section A

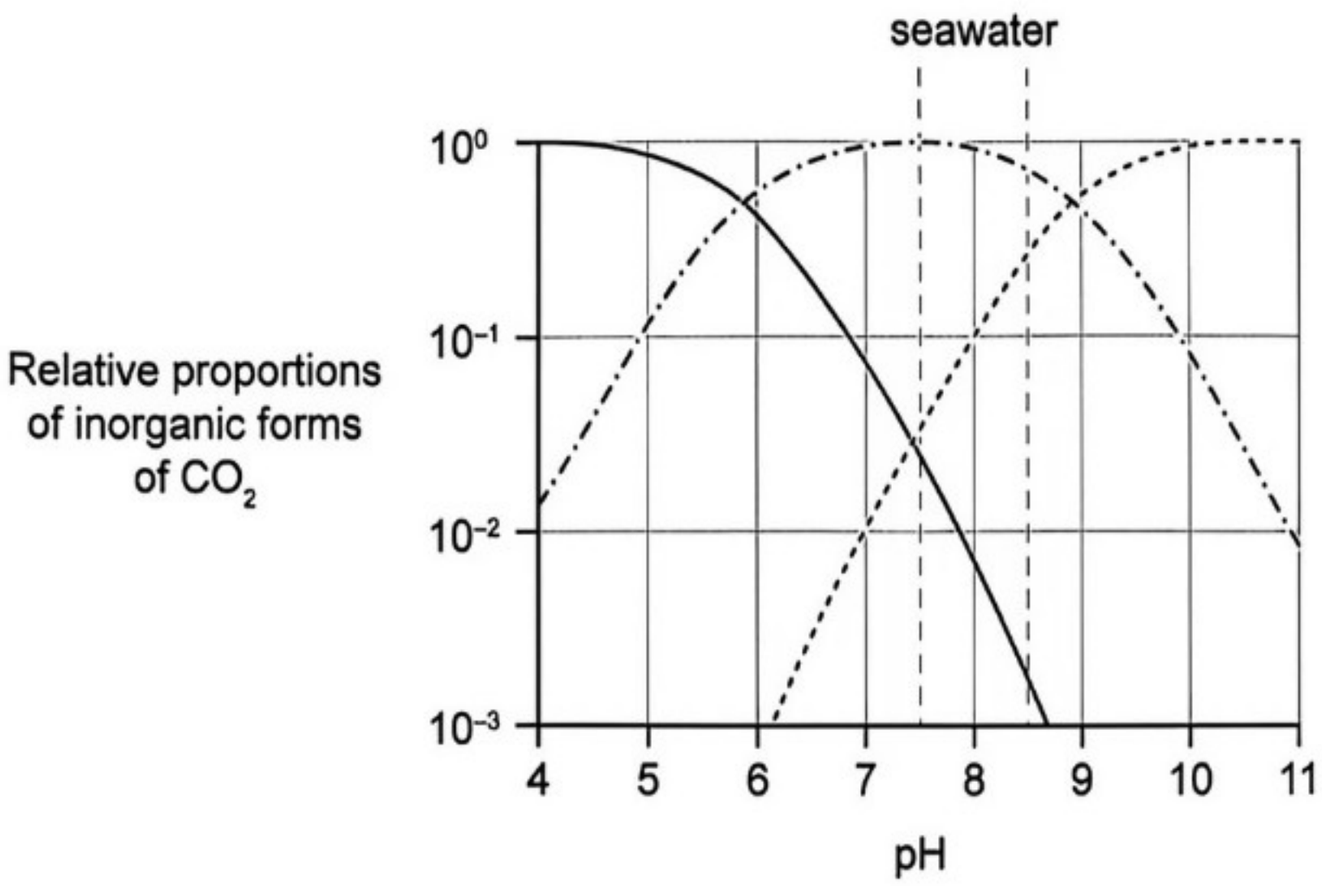
Answer **all** questions. Answers must be written within the answer boxes provided.

1. In the oceans, carbon dioxide (CO_2) dissolved in seawater exists in three main inorganic forms: aqueous CO_2, bicarbonate ions (HCO_3^-) and carbonate ions (CO_3^{2-}). All three forms of dissolved CO_2 are important for the biological processes of marine organisms. Oceans have an average pH globally of about 8.2. However, pH can vary by ±0.3 due to local, regional and seasonal factors.

The graph shows the relative proportions of inorganic forms of CO_2 dissolved in seawater at a range of pH levels. The range of pH that is likely to be found in the oceans now and in the future is pH 7.5–8.5.

Key:

— aqueous CO_2 –·– bicarbonate ions (HCO_3^-) --- carbonate ions (CO_3^{2-})



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A005

(a) Identify the form of dissolved CO_2 that is most abundant in seawater. [1]

bicarbonate ions

(b) State the relationship between aqueous CO_2 and carbonate ions (CO_3^{2-}). [1]

inversely related

As the relative proportion of aqueous CO_2 increases, the relative proportion of CO_3^{2-} decreases

(This question continues on the following page)

(Question 1 continued)

(c) Identify **one** natural factor that might influence the pH of seawater. [1]

marine organism respiration
(or) Volcanic activity
(or) photosynthesis of aquatic algae / plants.

Scientists have predicted that the oceans may change in the year 2100 due to CO_2 emissions from industry. The table shows past and two predicted changes to atmospheric CO_2, ocean composition and pH. The predictions were estimated using modelling techniques for the year 2100.

	Pre-industrial (mid-1800s levels)	**2005 levels**	**2× pre-industrial levels**	**6× pre-industrial levels**
Atmospheric concentration of CO_2 / parts per million	280	380	560	1680
HCO_3 / mol kg^{-1}	1768	1867	1976	2183
CO_3^{2-} / mol kg^{-1}	225	185	141	57
Total dissolved inorganic carbon / mol kg^{-1}	2003	2065	2136	2296
Average pH of oceans	8.18	8.07	7.92	7.49

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(d) Calculate the percentage change of HCO_3 from pre-industrial levels to the 2× pre-industrial levels estimate. [1]

$\frac{1976 - 1768}{1768} \times 100\% = 11.8\%$.

11.8 %

A005

(e) Suggest a reason for the researchers modelling 2× and 6× pre-industrial levels estimates for the year 2100. [1]

To predict different possible future atmospheric CO_2 emission, assess the severity of ocean acidication.

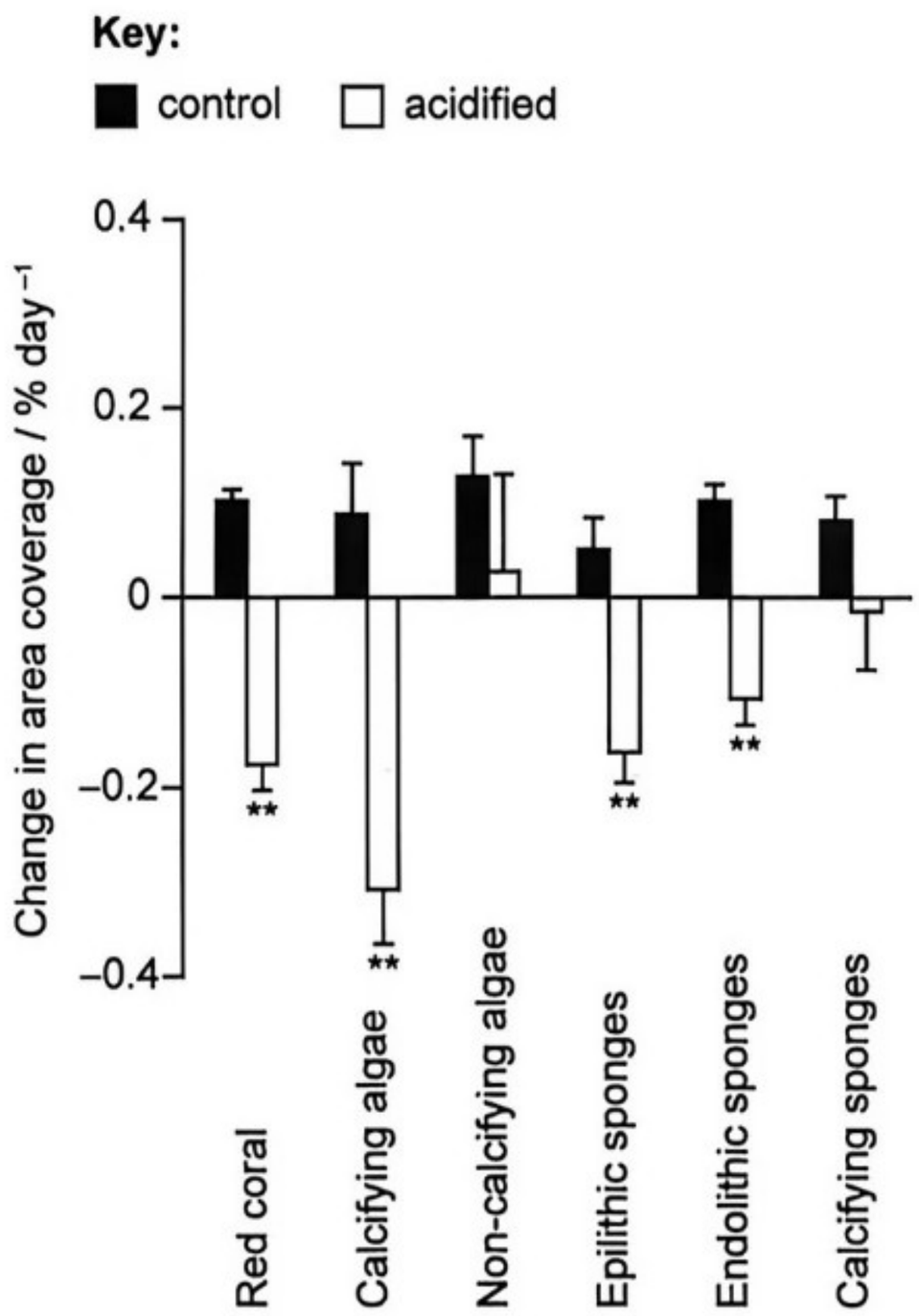
(This question continues on the following page)

(Question 1 continued)

A separate study investigated the effect of acidification on different reef species in mesocosms.

The graph shows the changes in the growth rates of different reef species when subjected to an acidification treatment and a control treatment. The growth rates are expressed as percentage change in area covered by the species.

Asterisks indicate significant differences (**$p < 0.01$) in the acidified treatment compared with the respective control.



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(f) Outline a possible control treatment. [1]

. Use . . seawater . at . . normal . . ocean . pH, . . all . . other . . conditions . . are . . same . as . . the . acidification . . treatment . . . . . .

(This question continues on the following page)

(Question 1 continued)

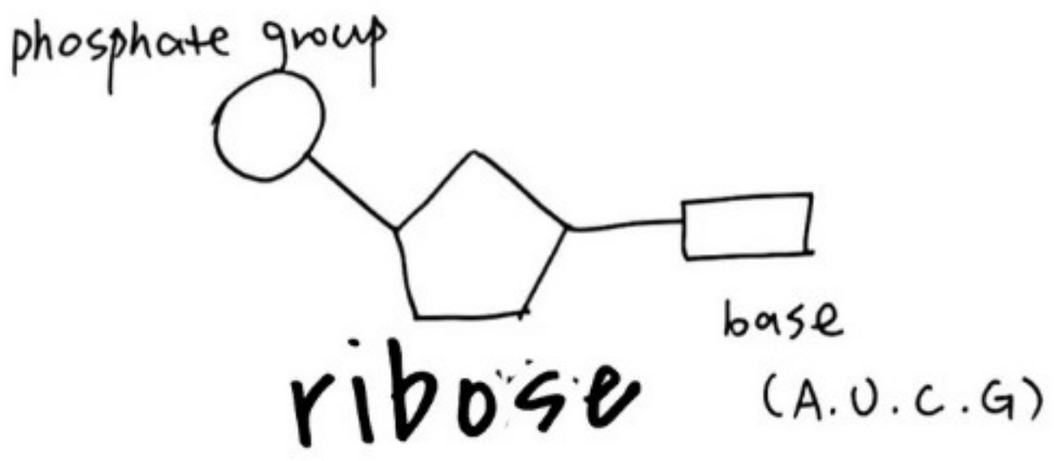
(g) Compare and contrast the effects of the treatments on the calcifying and non-calcifying algae. [3]

S:
Both have lower area coverage under acidified condition.
D:
Under acidified condition, Calcifying algae shows negative percentage change, while non-calcifying algae shaws positive change.
The difference is statistically significant for calcifying algae, but not for non-calcifying algae.

(h) Using all the data provided, predict the impact of CO_2 levels on reef species by the year 2100. [3]

As CO_2 levels rise and ocean acidification increases, calcifying organisms may experience reduced growth rate due to less CO_3^{2-} ions for shell formation; non-calcifying algae may experience increased growth rate due to more CO_2 for photosynthesis.
by 2100, the structure of reef community may change/shift. habitat complexity and biodiversity on coral reefs alter...

2. (a) Draw a labelled diagram to show the components of an RNA nucleotide. [3]



(b) State the type of chemical reaction that joins two nucleotides. [1]

condensation reaction

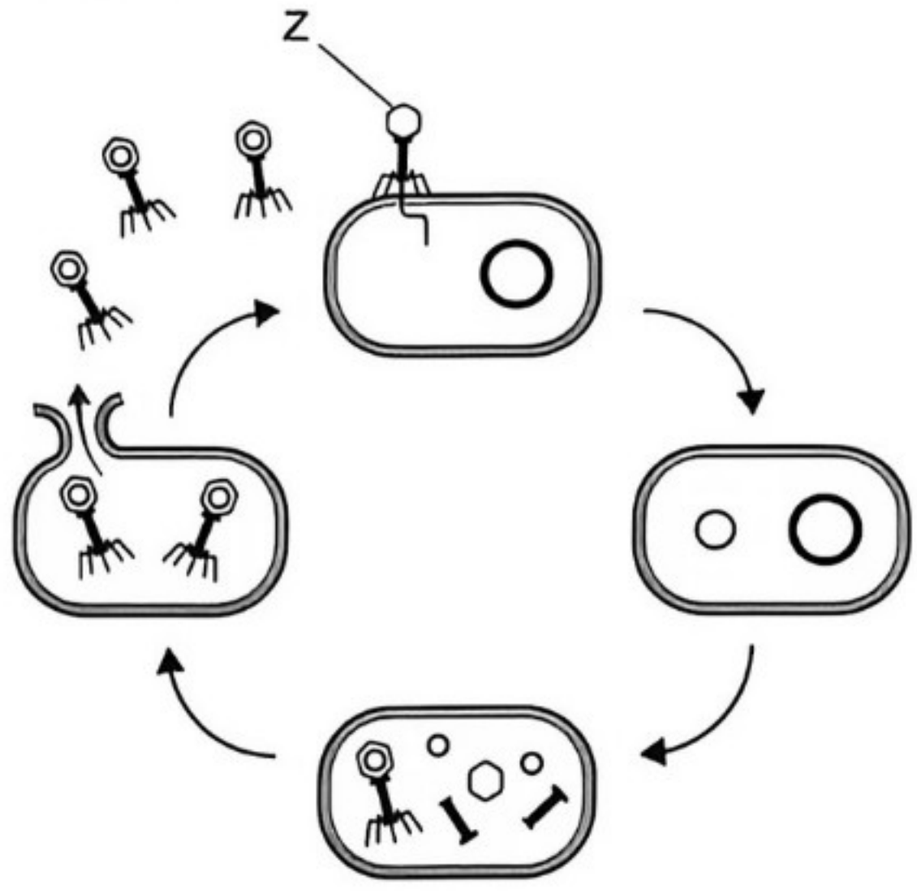
(c) Outline the production of mRNA by transcription. [3]

1. Initiation: RNA polymerase binds to promotor of DNA. DNA double strands unwind
2. Elongation: RNA polymerase moves along the template strand in the 3'→5' direction, synthesising a complementary mRNA strand
3. Termination: transcription ends, the RNA polymerase detaches, DNA rewinds

(d) Describe how mRNA is modified before leaving the nucleus. [2]

1. 5' Capping: A modified guanine nucleotide is added to the 5'-end of the mRNA
2. 3'-end of the mRNA is linked with a poly-A tail
3. RNA splicing: Introns are removed, exons are joined together.

3. The diagram shows viral replication.



(a) State the name of the viral structure labelled Z. [1]

....protein..coat.....

(b) Identify the type of life cycle shown in the diagram, giving a reason for your choice. [2]

....Lytic..cycle.....
....The.virus.injects.its.genetic.material,.assembles.new.viral.particles
and..causes..lysis..of..the..host..cell.....
.....No.evidence.of.integration.into.the..host..genome.....

(c) State the mode of existence of all viruses. [1]

....Obligate...intracellular...parasites.....
.....

(d) Discuss the evidence for several origins of viruses. [2]

...Virus-first.hypothesis:..Viruses.~~is~~.evolved.before.or..co-.evolved.with
their..current..host..cells.....
....Escaped.gene.hypothesis:..viruses.arose.from.genetic.elements.that
gained..the.ability..to.move.....
Regressive/Reduction hypothesis: viruses are remnants of cellular
organisms.

4. Compare and contrast the organelles in animal and fungal cells. [4]

Animal cells fungal cells

S: both have ~~cell wall~~ cytoplasm, cell membrane, nucleus,

~~D~~ both have ribosomes, mitochondria

both have ER and Golgi apparatus,

D: have no cell wall have cell wall

have lysosomes have no lysosomes

have centrioles have no centrioles

5. (a) The table shows some information about the endocrine system. State the gland, hormone and function missing from the table. [3]

Gland	Hormone	Function
pineal	melatonin	circadian rhythm
Adrenal gland	epinephrine (adrenaline)	fight-or-flight response
pituitary	antidiuretic hormone	Reduce urine production.

(b) The pancreas produces the hormone glucagon. Explain how glucagon is used to maintain constant blood glucose levels. [3]

When blood glucose concentration drops, α cells in the pancreas detect the change and secrete glucagon into the bloodstream. Glucagon acts on liver cells, stimulating the breakdown of glycogen into glucose, and promoting gluconeogenesis, therefore, blood glucose levels raise back to normal.

6. The CCR5Δ32 allele has been linked to resistance to bubonic plague, although these claims are controversial.

(a) State the cause of a new allele forming. [1]

...Mutation.....

(b) The infectious disease bubonic plague transfers from other species to humans. State the name for this type of disease. [1]

....Zoonose.....

(c) The frequency of the CCR5Δ32 allele is higher in areas where bubonic plague is common. Explain the reason for this. [3]

.....In areas where bubonic plague is common, individuals carrying the CCR5Δ32 allele have a survival advantage because they are more resistant to the disease. So they are more likely to survive, reproduce and pass on their allele to their offspring, over generations, the frenquency of this allele increases. This process is natural selection.....

7. (a) State the name for a genotype of individuals with one dominant and one recessive allele. [1]

heterozygous

(b) Distinguish between dominant and recessive alleles. [1]

represented by letter in upper case ... lower case
has the same effect on the ... has the same effect on the phenotype
phenotype whether it's present ... only when present in the homozygous state.
in homozygous or heterozygous state

(c) Carriers are individuals who possess one allele for a genetic condition but have no symptoms of that condition. Phenylketonuria (PKU) is a human disease caused by a recessive allele (d). Construct a Punnett grid to show the probability that two carrier parents will have a child with PKU. [2]

Parental generation — carrier Dd × carrier Dd

Gametes: (D) (d) × (D) (d)

	½D	½d
½D	¼DD normal	¼Dd normal
½d	¼Dd Normal	¼dd PKU

offspring genotypes DD : Dd : dd
1 : 2 : 1

phenotypes Normal : PKU
3 : 1

(d) Haemophilia is a genetic disorder. Explain the reason that males cannot be carriers of this condition. [2]

Haemophilia is caused by a recessive allele in X chromosome
Males have sex chromosomes as X and Y,
If a male has a dominant allele in X, he is not affected.
If a male has a recessive allele in X, he is affected

Section B

Answer **two** questions. One additional mark is available for the construction of your answers for each question. Answers must be written within the answer boxes provided.

8. Blood transports gases such as carbon dioxide and oxygen.

(a) Outline the structure of a haemoglobin molecule. [3]

(b) Explain how the Bohr shift allows more oxygen to be supplied to actively respiring tissues. [8]

(c) Describe the adaptations of red blood cells (erythrocytes) to their function. [4]

9. Animals are adapted to survive in many habitats.

(a) Outline how animal cell membranes are adapted to habitats of different temperatures. [3]

(b) Describe the adaptations of herbivores for feeding on plants and of plants for resisting herbivory. [5]

(c) Explain how the abiotic features of a hot desert biome result in **three** adaptations of a **named** animal for survival. [7]

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10. Membranes are important for allowing substances to move in and out of cells and organelles.

(a) Outline the changes that occur to plant cells when plant tissue is bathed in a hypotonic solution. [4]

(b) Describe how a resting potential is established and maintained. [4]

(c) Explain the role of the electron transport chain in the generation of ATP by cellular respiration. [7]

A005

8 a = protein / conjugated protein
= four polypeptide chains / two α-chains and two β-chains
= each chain is held around a haem group
= each haem group has an atom of iron

b = In respiring tissues, the concentration is high
= oxygen is released from the oxyhaemoglobin more readily
= due to protons from the dissociation of carbonic acid
= So the increase in carbon dioxide concentration shifts the oxygen dissociation curve to the right
= This benefits respiring cells with increased metabolism
= Greater amounts of CO_2 are released
= Hb releases its O_2 at regions of greatest respiratory rate
= O_2 is needed for aerobic cell respiration

c = small size, about 8 μm, fit through the small lumen of capillaries
= small size, have a large SA:V ratio, allowing fast diffusion
= biconcave shape, short diffusion distance
= lack of nucleus, more room for haemoglobin

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9.a. In cold enviroments
= higher proportion of unsaturated fatty acids
= The kinks prevent tight packing,
= contains more cholestero|
= maintain membrane fludity at low temperature
In warm enviroments
= higher proportion of saturatted fatty acids
= tightly pack
= prevent the membrane from being too fluid at high temperature

for
b. Adaptations of herbivores feeding on plants
= teeth: Incisors for cutting plant materials
Large flat molars for grinding
= Digestive system: long tracts
four chambered stomach (Ruminants)
mutualistic bacteria for digesting cellulose
Adaptations of plants for resisting herbivory
= mechanical defense: spines thorns tough leaves
= chemical defense: toxins bitter compounds
= ~~inde~~ indirect defense: matter to attact predators of herbivores

c. Abiotic features of a ~~hort~~ hot desert biome
= high temperatures, strong solar radiation
= low water availability
= large temperature fluctuations
Adaptions of camels
= can tolerate a wide of body temperatures
= sweat little
= can drink large amout of water
= store fat in humps, produce water from metabolizing fats.
= produce highly concentrated urine and dry feces

10. a. A hypotonic solution has a higher water potential than the cell contents
water moves into the cell by osmosis down the water potential gradient
The vacuole swells, cell membrane / cytoplasm pushs against the cell wall
The plant cell becomes tugid
The cell wall prevents the cell from bursting.
No net water movement once the turgor pressure balances the osmotic influx

b. Sodium-potassium pumps actively transport 3 Na^+ out of the cell and 2 K^+ ~~in to~~ into the cell
ATP is used
This creats a concentration gradient
The membrane is more permeable to K^+ than Na^+ at rest.
K^+ diffuse out of the cell
the outward movement of K^+ makes the inside of the cell negatively charged relative to the outside

c. ETC is located in the inner membrane of mitochondria.
Glycolysis and Kreb's cycle produce NADH and $FADH_2$.
NADH and $FADH_2$ release electrons
As electrons pass through protin complexes, energy is released
The released energy is used to pump protons from the matrix into the intermembrane space
An electronchemical gradient is created
Chemiosmosis
Protons diffuse back into the matrix through ATP synthase
The flow of protons provides energy for ATP synthases
Oxygen acts as the final electron ~~a~~ acceptor, to form water
Which prevents the ETC from being blocked