H

NATIONAL JUNIOR COLLEGE, SINGAPORE
Senior High 2
Preliminary Examinations
Higher 2

CANDIDATE NAME			
BIOLOGY CLASS	2bi2_____	REGISTRATION NUMBER	

Biology

9744/02

Paper 2

29 August 2019

2 hours

Candidates answer on the Question Booklet.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name and Biology class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** parts of the question in the spaces provided on the Question Booklet.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your workings or if you do not use appropriate units.

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

For Examiner's Use	
1	/12
2	/12
3	/14
4	/14
5	/12
6	/10
7	/12
8	/14
Total	/100

This document consists of **24** printed pages.

Answer **all** the questions.

1 Fig. 1.1 below shows a section of a cell surface membrane.

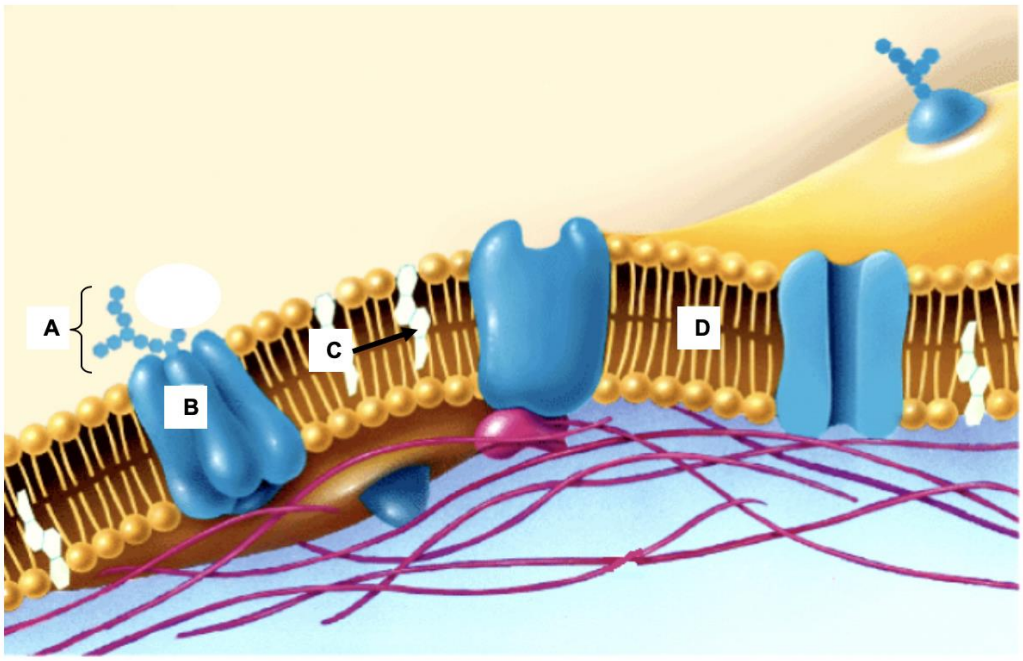

Fig. 1.1

(a) (i) Name the structures labelled **C** and **D**.

C: .....

D: ..... [2]

(ii) Describe **three** possible functions of the structure labelled **A**.

.....

.....

.....

.....

.....

..... [3]

(b) Listed below is the amino acid sequence that makes up the transmembrane segment of structure **B**.

… Ile – Thr – Leu – Ile – Tyr – Phe – Gly – Val – Met – Ala –
Gly – Val – Ile – Gly – Thr – Ile – Leu – Leu – Ile – Ser – …

Suggest why such an amino acid sequence would enable the protein to span the membrane.

[3]

(c) For hydrophilic molecules to enter a cell, they require the help of either carrier proteins or channel proteins.

State which kind of membrane proteins can transport molecule at a faster rate and give reasons to support your answer.

[4]

[Total: 12]

2 **(a)** Many amino acids are needed to form the structure of a typical haemoglobin molecule shown in Fig. 2.1.

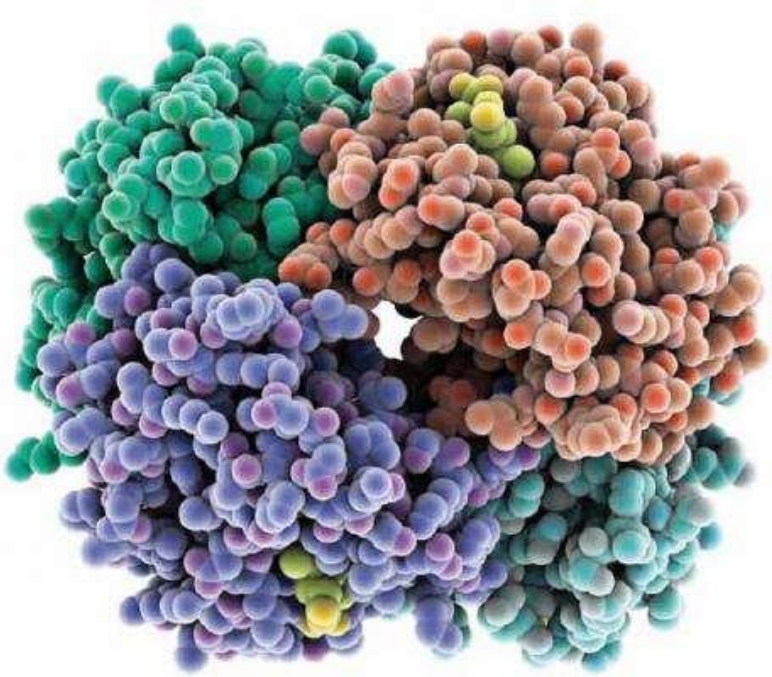

Fig. 2.1

Briefly describe how the structure of haemoglobin is adapted for its function.

.....

.....

.....

.....

.....

..... [3]

(b) Fig. 2.2 shows a three-dimensional model of an important signal molecule XDF in glucose regulation. It is used to send signals to the cells of the Islets of Langerhans to make insulin. XDF is a globular protein made up of 212 amino acids.

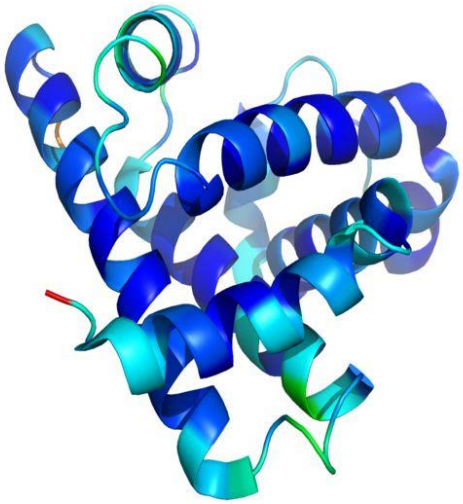

Fig. 2.2

(i) Explain what determines the three-dimensional shape of the XDF.

[3]

(ii) Suggest the consequence of the shape of XDF to its function, when subjected to high pH treatment.

[2]

(c) An experiment was carried out to monitor the changes in blood glucose level and blood insulin level in a healthy individual over a 12-hour period. Table 2.1 below shows the results of the experiment.

Table 2.1

time	meal taken	average blood insulin level / units per 100 ml	average blood glucose level / units per 100 ml
0900	Yes	10	100
1000	No	65	170
1100	No	10	110
1200	No	10	100
1300	No	10	100
1400	Yes	10	100
1500	No	70	165
1600	No	10	110
1700	No	10	100
1800	Yes	10	100
1900	No	70	180
2000	No	10	110
2100	No	10	100

With reference to Table 2.1, outline how blood insulin level is regulated in the body.

[4]

[Total: 12]

3 Fig. 3.1 shows the eukaryotic chromatin in two states, **A** and **B**.

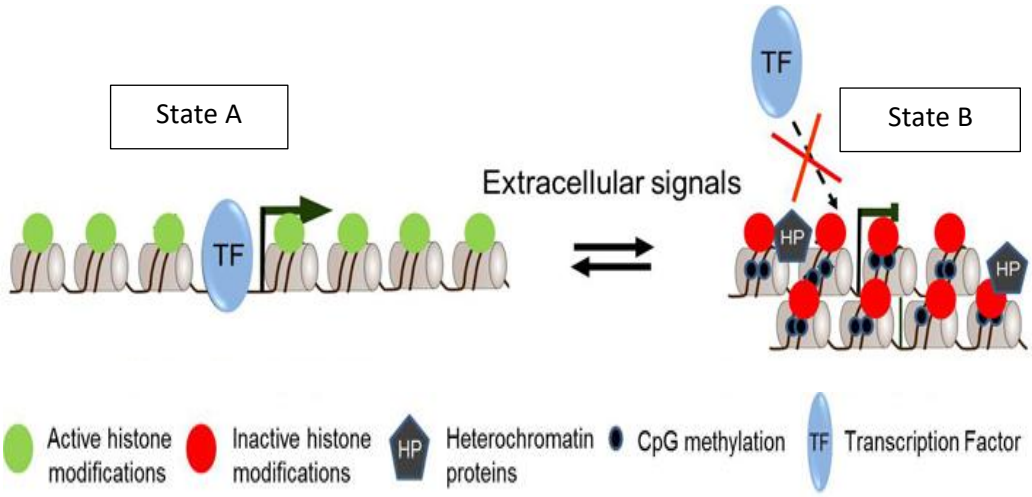

Fig. 3.1

(a) (i) State the type of chromatin in state **A** and in state **B**.

A: .....

B: ..... [2]

(ii) Using your knowledge of histone modification, describe the process that may give rise to chromatin in state **A**.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(b) Describe how the difference in the structure of DNA in state **A** and **B** affects gene expression.

[2]

(c) Eukaryotic DNA has non-coding regions that do not get transcribed and some that may be transcribed but not translated. One such example is the promoter sequence.

Apart from the non-coding DNA involved in regulation of transcription, state and describe the roles of three other types of non-coding DNA.

[6]

[Total: 14]

4 **(a)** The electron micrographs below shows the organelles of a eukaryotic cell.

Fig. 4.1

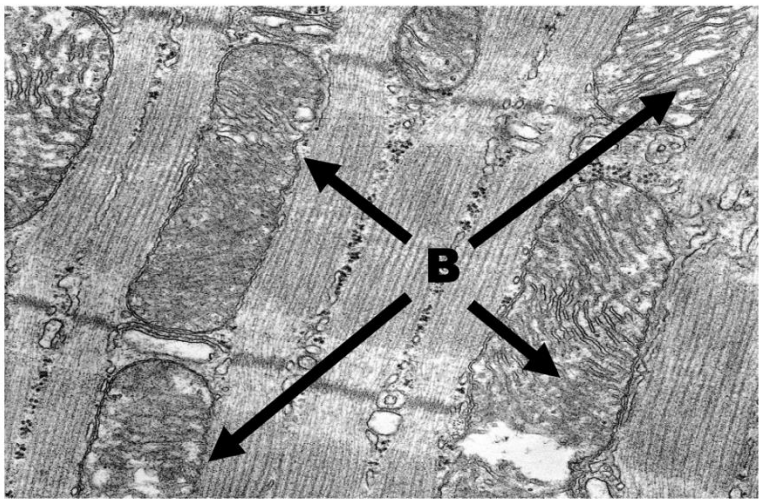

Fig. 4.2

(i) Name the structures labelled **A** (Fig. 4.1) and **B** (Fig. 4.2).

A: .....

B: ..... [2]

(ii) State two similarities and two differences in the structural features of **A** and **B**.

.....

.....

.....

.....

.....

.....

..... [4]

(b) Fig. 4.3 is a scaled up image of Fig. 4.2 depicting a single organelle **W**. The labelled arrows **X** and **Y** both represent a structural feature of **W**.

200X magnification

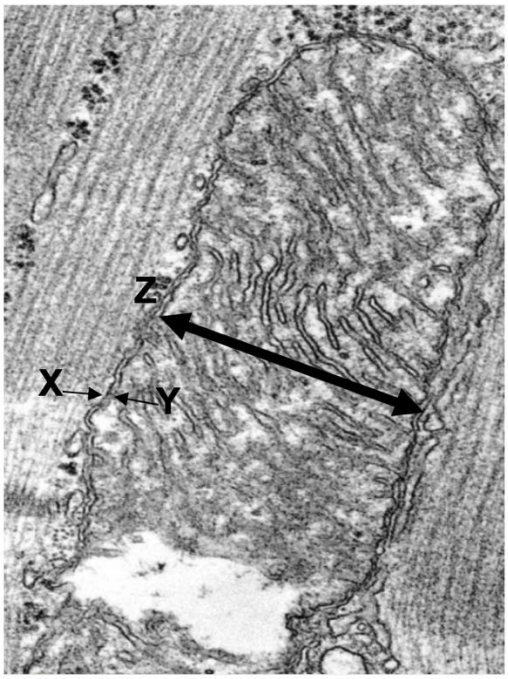

Fig. 4.3

The table below shows the protein composition of various areas in organelle **W** in Fig. 4.3.

Table 4.1

labels	Protein composition (%)
X	6
Y	21
Region between **X** & **Y**	6
Inside **W**	67
Total	100

Using the information in Table 4.1 above, account for the

(i) abundance of protein inside organelle **W**.

.....

.....

.....

..... [2]

(ii) greater amount of protein in **Y** compared to **X**.

.....

.....

.....

.....

.....

..... [3]

(iii) Calculate the **actual** width of the organelle at the position marked by line **Z** in Fig. 4.3.

You should show your working and use appropriate units.

[3]

[Total: 14]

5 Growth and development in organisms is controlled by a number of mechanisms that operate at the cellular level. The control elements involved in these mechanisms include hormones, the second messenger molecule cyclic AMP and regulatory genes.
In eukaryotes the most important regulatory genes contain homeobox sequences and are called homeotic genes.

The regulatory genes of the *lac* operon in prokaryotes are studied to help us to understand how regulatory genes and their products interact to switch structural genes on and off.

(a) Use your understanding of the biochemical identity and interactions of these control elements to complete Table 5.1 by putting a tick (✓) or a cross (✗) **in each box**.

Table 5.1

control element	made of protein	binds with a protein	codes for a protein
insulin		✓	
cyclic AMP			✗
lac I gene		✓	
lac O gene	✗		
Homeotic gene product		✗	

[5]

(b) RNA polymerase and DNA polymerase are both enzymes. RNA polymerase is involved in the action of some control elements, whereas DNA polymerase is not.

Describe and explain the difference between the **functions** of these two enzymes.

[4]

(c) The control of the expression of the *lac* operon genes, which allow uptake and digestion of lactose in the bacterium *Escherichia coli*, is well known.

Fig. 5.1 shows the arrangement of the elements of the *lac* operon.

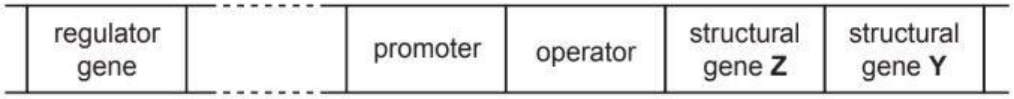

Fig. 5.1

Describe how genes **Z** and **Y** are switched on in bacteria that are moved to a nutrient medium that contains lactose.

[3]

[Total: 12]

6 **(a)** Fig. 6.1 represents part of a DNA molecule.

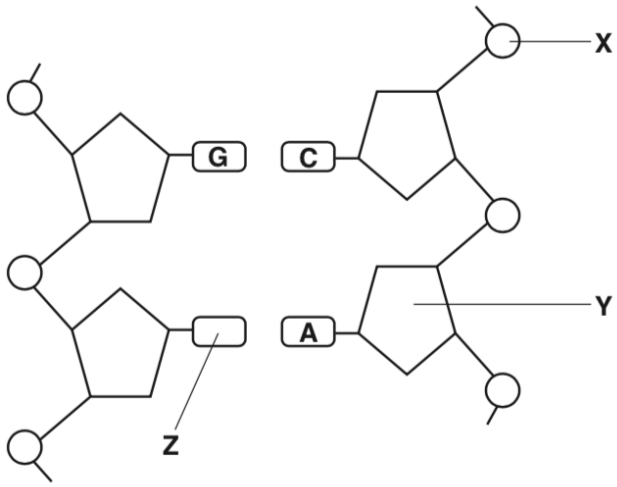

Fig. 6.1

(i) State the **precise name** of each of the parts of the DNA molecule labelled **X, Y,** and **Z.**

X: .....

Y: .....

Z: ..... [3]

(ii) Describe how the DNA molecule replicates.

.....

.....

.....

.....

.....

.....

.....

.....

..... [5]

(b) Explain why the mRNA molecule is shorter than a DNA molecule.

.....

.....

..... [2]

[Total: 10]

7 Vaccination can protect against the infectious disease tuberculosis (TB).

(a) Define the terms:

(i) vaccination

.....

.....

.....

..... [2]

(ii) infectious disease.

.....

.....

.....

..... [2]

(b) TB is an important disease worldwide. Table 7.1 shows recent information about TB cases reported during one year in six different countries.

Table 7.1

country	region	number of cases	number of cases per 100 000 population
Germany	Europe	4000	5
India	Asia	2 300 000	185
Japan	Asia	27 000	21
South Africa	Africa	490 000	981
Swaziland	Africa	15 000	1287
United Kingdom	Europe	7900	13

With reference to Table 7.1, explain the advantage of calculating the number of cases of TB per 100 000 population rather than stating the number of cases alone.

[2]

(c) Describe how a person may become infected with TB.

[3]

(d) Suggest why TB is more likely to be fatal in people who have HIV/AIDS than in those who do not have HIV/AIDS.

[3]

[Total: 12]

8 **(a)** Sometimes a gene has more than two alleles, termed *multiple alleles.* The ABO blood group system in humans is controlled by a gene with three alleles, I^A, I^B, and I^O. Alleles I^A and I^B are codominant and I^O is recessive to both.

Explain what is meant by *codominance*.

[3]

(b) In humans, a gene that codes for the production of a protein, called factor VII, is located on the X chromosome. The dominant allele for this gene produces factor VIII, but the recessive allele does not produce factor VIII.

A person who is unable to make factor VIII has haemophilia in which the blood fails to clot properly.

Explain why a man with haemophilia cannot pass haemophilia to his son but may pass haemophilia to his grandson.

[3]

(c) A gene for feather colour in chickens is carried on an autosome. This gene has two alleles, black (C^B) and splashed-white (C^W). When a male chicken with black feathers is mated with a female chicken with splashed-white feathers, all the offspring have blue feathers. This also occurs when a male chicken with splashed-white feathers is crossed with a female with black feathers.

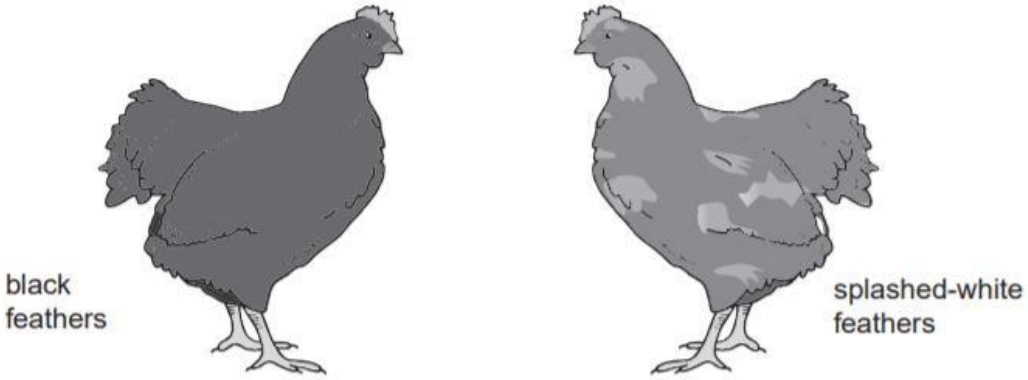

Fig. 8.1

Another gene may cause stripes on feathers (barred feathers). This gene is carried on the X chromosome. The allele for barred feathers (X^A) is dominant to the allele for non-barred feathers (X^a).

In chickens the male is homogametic and has two X chromosomes while the female is heterogametic and has one X chromosome and one Y chromosome.

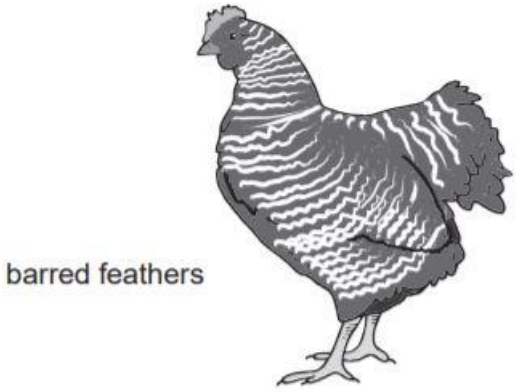

Fig. 8.2

(i) A male chicken with black, non-barred feathers was crossed with a female chicken with splashed-white, barred feathers. All the offspring had blue feathers, but the males were barred and the females were non-barred.

Using the symbols given above draw a genetic diagram to show this cross.

[5]

(ii) Explain how a farmer could use a breeding programme to find out the genotype of a male chicken with blue, barred feathers.

.....

.....

.....

.....

.....

..... [3]

[Total: 14]

BLANK PAGE

BLANK PAGE

BLANK PAGE