Civics Group	Index Number	Name (use BLOCK LETTERS)	H1

ST ANDREW'S JUNIOR COLLEGE
2022 JC2 Weighted Assessment 4

H1 BIOLOGY **8876**

STRUCTURED QUESTIONS & ESSAY

50 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, civics group and index number 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 diagram, graph or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
All working for numerical answers must be shown.

Conceptual error (C)	Data Quoting (D)	Expression (E)	Misreading the question (Q)

For Examiner's Use	
STQ 1	/9
STQ 2	/10
STQ 3	/14
Total	**/33**

This document consists of XX printed pages.

[Turn over

STRUCTURED QUESTIONS

QUESTION 1

Fig. 1.2 shows an electron micrograph of part of an acinar cell found in the pancreas.

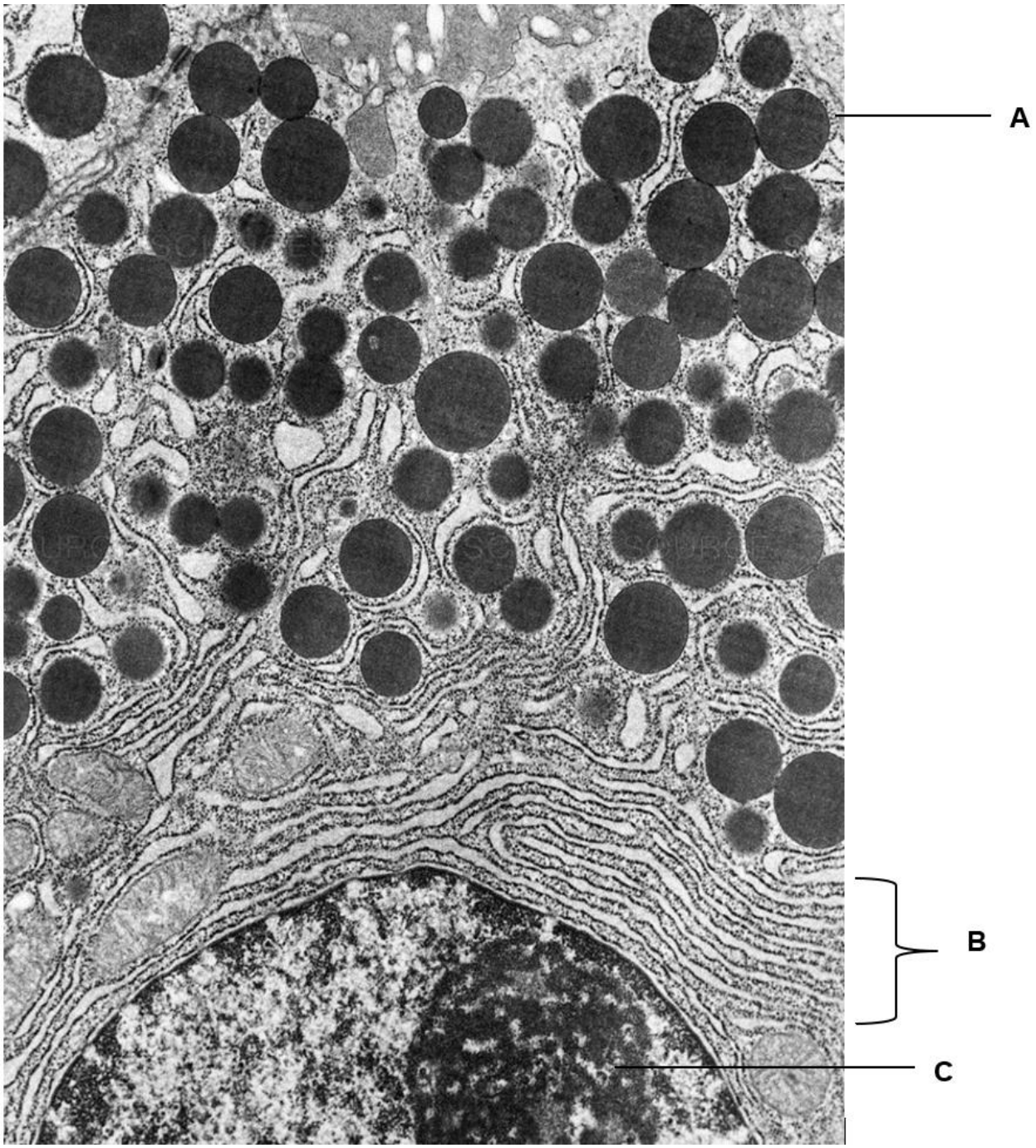


Fig. 1.1

(a) With reference to Fig. 1.1,

(i) Identify organelle **A**

..... [1]

1 Secretory vesicle

(ii) Explain how organelle **A** can become part of the cell surface membrane.

..... [1]

1 Secretory vesicle moves along microtubules and **fuses** with the cell surface membrane during **exocytosis**;

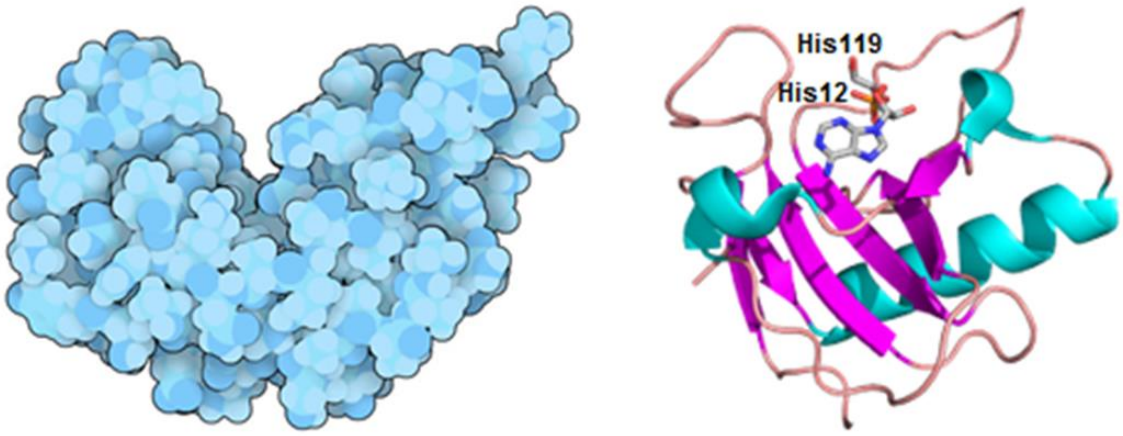
(iii) Describe the differences in structure and function between organelles **B** and **C.**

..... [2]

Structure	**B (rough endoplasmic reticulum)**	**C (nucleolus)**
Membrane bound or not	**Single** membrane bound	Not membrane bound
Ribosomes	Ribosomes embedded on outer surface	No ribosomes
Function	**Transport** and package **proteins** in transport vesicles to **golgi apparatus/other organelles/ out of cell for secretion** Reject: site of protein synthesis	Site of **rRNA synthesis**/ **assembly of rRNA and proteins** to form **ribosomal subunits**

(b) In eukaryotic cells, the degradation of mRNA is an essential part of the regulation of gene expression. It can be controlled in response to developmental, environmental, and metabolic signals.

mRNA hydrolysis is catalysed by numerous types of nucleases, such as the endonuclease Ribonuclease A (RNAse A), shown in Fig. 1.2A**.**



(A) Space-filling model (B) Ribbon diagram

Fig. 1.2

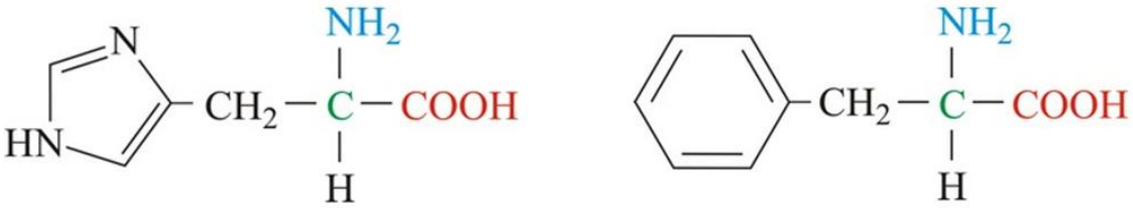
(i) Fig. 1.2B shows two important catalytic residues within the active site of RNAse A, which are His12 and His119.

Explain how these two histidines, which are in position 12 and 119 of the 124 amino acid sequence, are brought together in the active site of the enzyme.

…… [3]

1 Primary structure + number, type and sequence of amino acid determines how the polypeptide chain folds upon itself;
2 To form the tertiary structure, which is stabilized by hydrogen, ionic, disulphide bonds and hydrophobic interactions between R groups of amino acids
3 Bringing faraway amino acids together within the active site;

(ii) Fig. 1.3 shows the structure of histidine and phenylalanine.



(A) Histidine (B) Phenylalanine

Fig. 1.3

Predict and explain how the catalytic activity of RNAse would be affected if both histidines were replaced by phenylalanines.

…… [2]

1 Histidine has an R-group that is polar whereas phenylalanine has an R-group that is non-polar;;

2 This causes the change in the interaction between the catalytic residues and the substrate at the active site; therefore; RNAase catalytic activity will be greatly reduced / lost;;

[Total: 9]

QUESTION 2

(a) Fig. 2.1 is a diagram showing DNA replication.

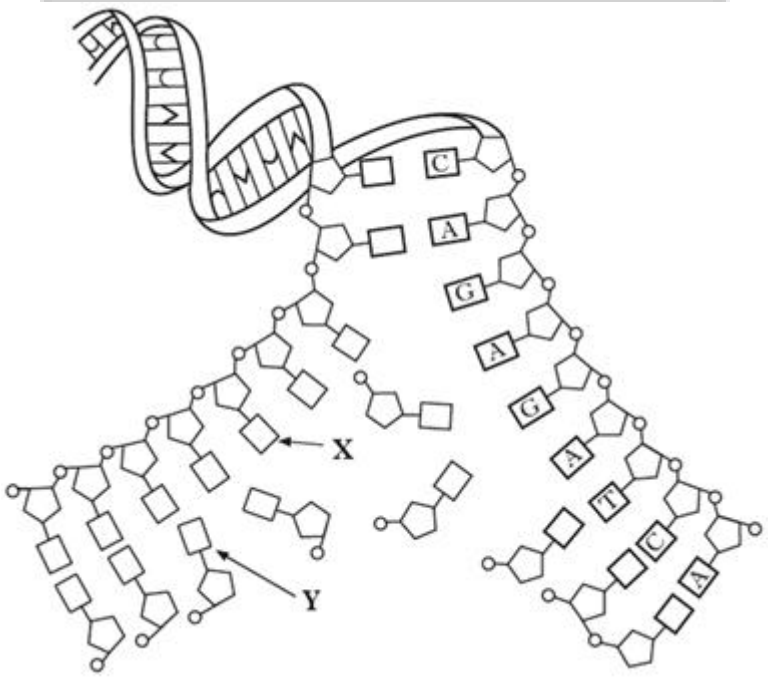


Fig. 2.1

(i) Identify the bases labelled **X** and **Y** on Fig. 1.1 and state whether they are purine or pyrimidine.

…… [1]

1 X: Cytosine (pyrimidine)
2 Y: Thymine (pyrimidine)

(ii) Explain how Fig. 2.1 shows semi-conservative replication.

…… [3]

1 The two parental DNA strands separate due to the **breaking of hydrogen bonds** between complementary bases;
2 Each strand acts as a template for the synthesis of new complementary DNA strands;
3 Each new DNA molecule contains one parental DNA strand and one newly synthesised daughter DNA strand;

(b) Fig. 2.2 is an electron micrograph showing the process of protein synthesis in a prokaryote.

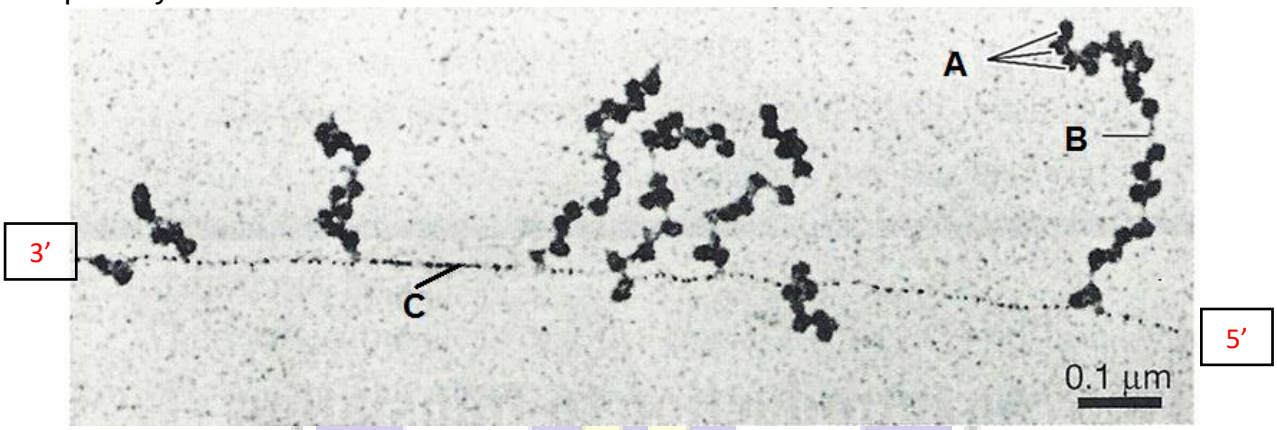


Fig. 2.2

(i) Identify structures **A** and **C**.

..... [1]

A: Ribosomes
C: DNA

(ii) Label in the boxes in Fig. 2.2 to show the 5' and 3' ends of the structure **C**. [1]

(c) Fig 2.3 shows the Calvin cycle that occurs during photosynthesis.

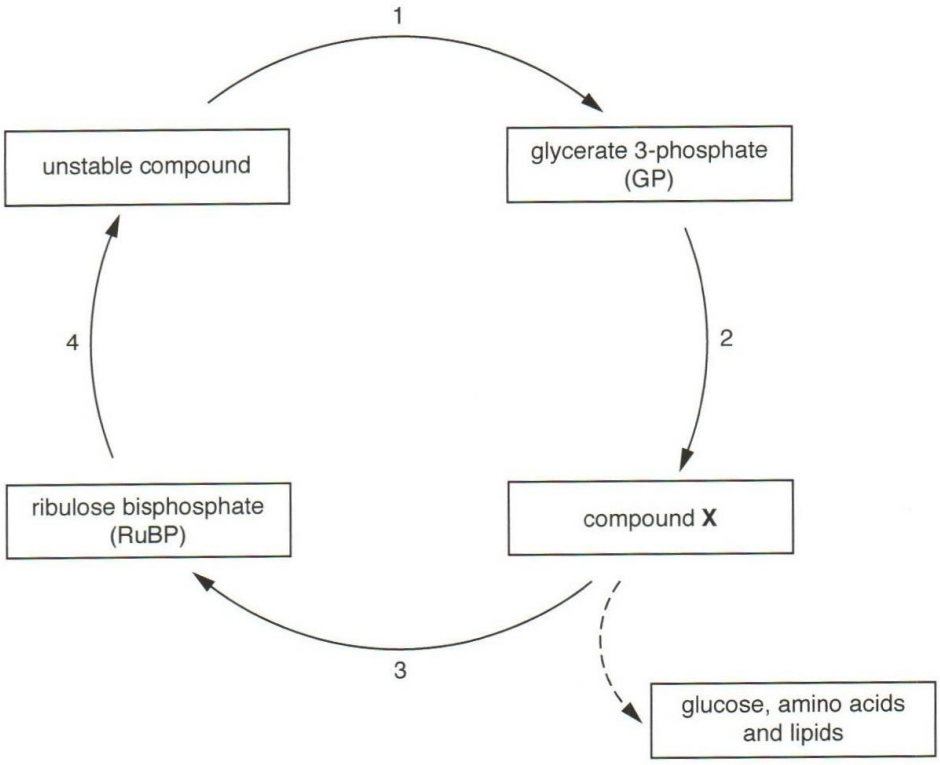


Fig. 2.3

(i) State the number of carbon atoms in one molecule of compound X.

……..…..... [1]

3

(ii) A plant undergoing active photosynthesis, was placed in an environment where there was no carbon dioxide. State the label number of the solid arrow that represents the reaction in Fig 8.1 inhibited by the absence of carbon dioxide.

……..…..... [1]

4

(iii) Identify a compound that would start to accumulate in the above scenario and explain why it accumulates.

……..…..... [2]

1 RuBP
2 No carbon fixation as lack of CO_2 to combine with RuBP to form PGA;
3 PGA is converted into PGAL, (some of) which is used to regenerate RuBP.

[Total: 10]

QUESTION 3

Fig. 1.1 is a photomicrograph of plant root cells near the growing tip. Some of the cells are undergoing mitosis.

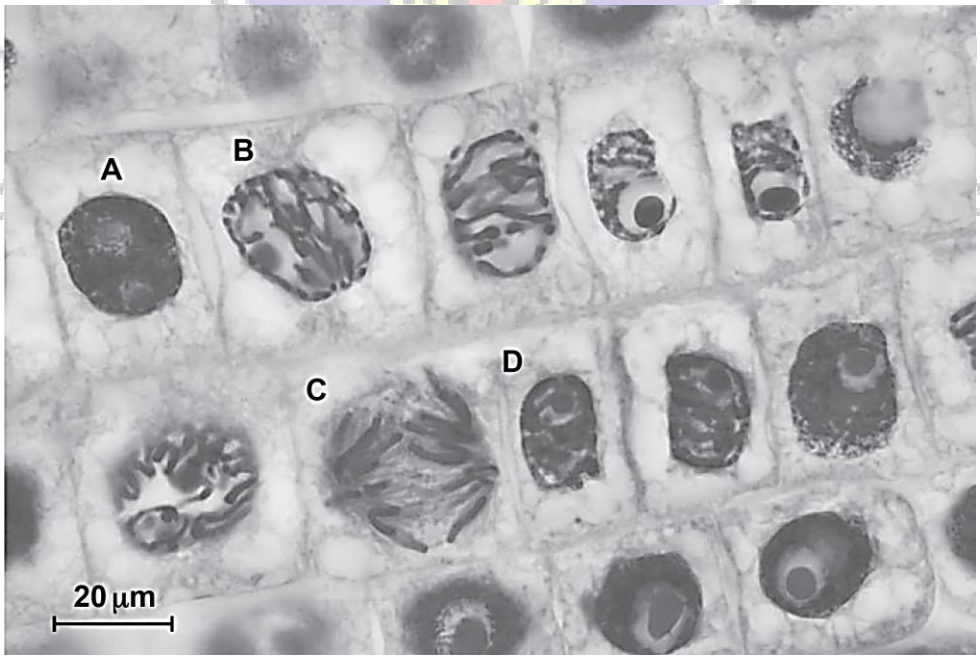


Fig. 3.1

(a) State the letter, **A** to **D**, of the cell in Fig. 2.1 which is in

(i) Prophase: ……

(ii) Anaphase: …….. [1]

Prophase: B
Anaphase: C

(b) Fig. 3.2A shows a DNA base sequence. It also shows the effect of two mutations on this base sequence. Fig. 3.2B shows DNA triplets that code for different amino acids.

Original DNA base sequence	A	T	T	G	G	C	G	T	G	T	C	T
Mutation 1 DNA base sequence	A	T	T	G	G	A	G	T	G	T	C	T
Mutation 2 DNA base sequence	A	T	T	G	G	C	C	T	G	T	C	T

Fig. 3.2A

DNA triplets	Amino acid
GGT, GGC, GGA, GGG	Gly
GGT, GTA, GTG, GTC	Val
ATC, ATT, ATA	Ile
TCC, TCT, TCA, TCG	Ser
CTC, CTT, CTA, CTG	Leu

Fig. 3.2B

Some mutations affect the amino acid sequences while others do not. Using the information in Fig. 2.2A and Fig. 2.2B, explain

(i) why mutation 1 has no effect on the protein structure.

…….…..... [2]

1 base substitution on the last DNA triplet from GGC to GGA encodes for the same amino acid, gly;

2 no change in amino acid sequence, no change in R group interactions, no change in protein folding

(ii) why mutation 2 could lead to the formation of a non-functional enzyme.

……..... [2]

1 substitution mutation from GTG to CTG changes the amino acid encoded from val to leu;
2 change in R group interactions, change in protein folding, change in active site configuration

(c) Some beetles have spines on their legs to help them capture prey. Three alleles determine the presence and type of spines a beetle will produce. The inheritance of a single L^C allele produces curved spines on the legs. The L^s allele is recessive to L^C allele, and produces straight spines. Beetles that are homozygous recessive for the L^n allele produces no spines on its legs.

When a beetle with curved spines was crossed with a beetle with straight spines, they produced the following offspring:

62 curved spines
28 straight spines
30 no spines

(i) Draw a genetic diagram to show the cross between the beetle with curved spines and the beetle with straight spines described above.

……..... [3]

Parental phenotype:	Curved spines	x	Straight spines	
Parental genotype:	L^CL^n	x	L^sL^n	
Gametes:	(L^C)	(L^n)	(L^s)	(L^n)
F_1 genotypes:	L^CL^s	L^CL^n	L^sL^n	L^nL^n
F_1 phenotypic ratio:	2 curved spines	: 1 straight spines	: 1 no spines	

Mark scheme:

1 Parental genotype match with phenotype
2 Gametes (circles)
3 F_1 genotypes match with phenotypes

(ii) An F_1 offspring with curved spines was picked at random. Describe how its genotype can be determined.

……..... [2]

1 Test cross it with a **homozygous recessive** beetle with no spines, L^nL^n

2 If the cross produces any beetles with no spines, the F_1 beetle with curved spines is L^CL^n. Otherwise, it is L^CL^s.

OR
If the cross produced beetles in the ratio 1 curved spines : 1 straight spines, the F_1 beetle was L^CL^s. If the cross produced beetles in the ratio of 1 curved spines : 1 no spines, the F_1 beetle was L^CL^n.

(d) The greater racket-tailed drongo, *Dicrurus paradiseus,* is an insect-eating bird found in tropical broadleaved forests in southern Asia from Kashmir, India and Sri Lanka east to Indonesia.

Fig. 3.3 shows the geographic variation in the form of the crest among populations of the greater racket-tailed drongo.

Fig. 3.3

Explain how natural selection may have resulted in the distinct phenotypic differences between the populations.

……..……..... [4]

1 **Genetic variations** exist among the drongo populations due to <u>mutations</u> ;
2 Predation exerts a selection pressure, e.g. smaller crests make the birds less conspicuous to predators, hence are at a selective advantage in environments with more predators.

3 These individuals **survived** better, reproduce more and pass on their alleles to offspring
4 **Change in allele frequency** of gene pool **over time** occurs;
5 Other evolutionary agents such **genetic drift** / founder's effect and bottleneck effect occur ;

[Total: 14]