RAFFLES INSTITUTION

2015 Year 6 Preliminary Examination
Higher 2

BIOLOGY 9648/01

Paper 1 Multiple Choice **29 September 2015**

1 hour 15 min

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name and shade your Index Number on the Answer Sheet in the spaces provided.

There are **forty** questions in this paper. Answer all questions. For each question there are four possible answers **A, B, C**, and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
Calculators may be used.

(Erase all mistakes completely. Do not bend or fold the Answer Sheet).

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

1 A sample of yeast cells was grown in a culture. Radioactive amino acids were added to the solution in which they were being grown. At various times, samples of the cells were taken and the amount of radioactivity in different organelles was measured. The results are shown in the table.

Time after radioactive amino acids were added to the solution / min	Amount of radioactivity present / arbitrary units		
	P	Q	R
1	21	120	6
20	42	68	6
40	86	39	8
60	76	28	15
90	50	27	28
120	38	26	56

Which best describes the identities of organelles **P**, **Q** and **R**?

	P	Q	R
A	Golgi apparatus	Rough endoplasmic reticulum	Secretory vesicles
B	Rough endoplasmic reticulum	Smooth endoplasmic reticulum	Golgi apparatus
C	Nucleus	Rough endoplasmic reticulum	Golgi apparatus
D	Smooth endoplasmic reticulum	Golgi apparatus	Secretory vesicles

2 The key below can be used to identify carbohydrates.

(1) Sugars…… go to **(2)**
Polysaccharides ……..…… go to **(4)**

(2) Monosaccharides ..……..……**A**
Disaccharides ……... go to **(3)**

(3) Contains only 1 type of monomer…….. **B**
Contains only 2 types of monomer…...… sucrose

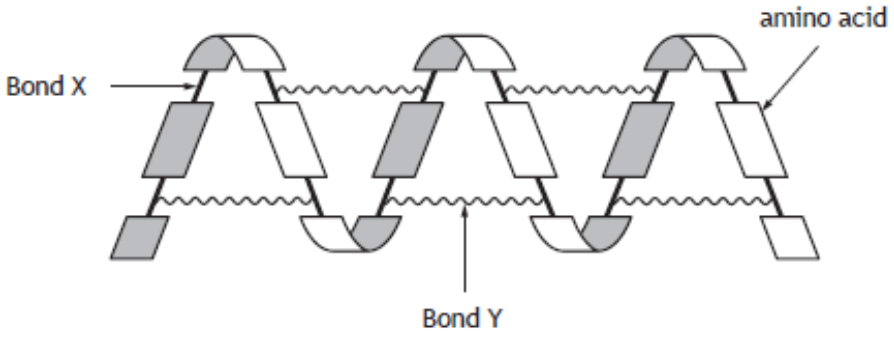
(4) Structural function……. go to **(5)**
Storage function ……..…….. go to **(6)**

(5) Structural function in plants..…..……..**C**
Structural function in animals..…….…..... collagen

(6) Storage function in plants..…..…… starch
Storage function in animals..…….……**D**

Which of the above is maltose?

3 The diagram below shows part of a protein molecule.



Which of the following statement(s) is/are correct?

I Bonds **X** and **Y** are both affected by substitution of an amino acid.

II Only Bond **Y** may be affected by a base deletion.

III Amino acids with bulky R groups may prevent Bond **X** from forming.

IV Formation of Bond **X** is affected by insertion of three bases.

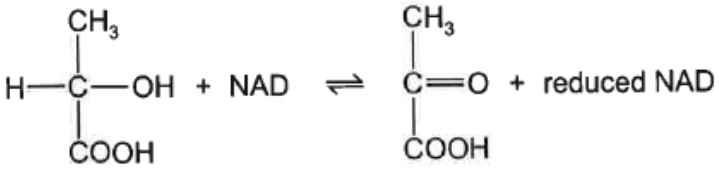
A **I** and **IV** only

B **II** only

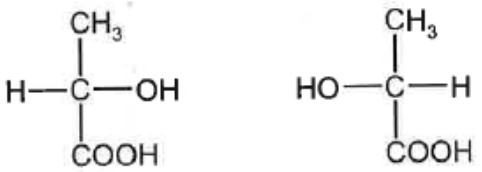
C **II** and **III** only

D All of the above

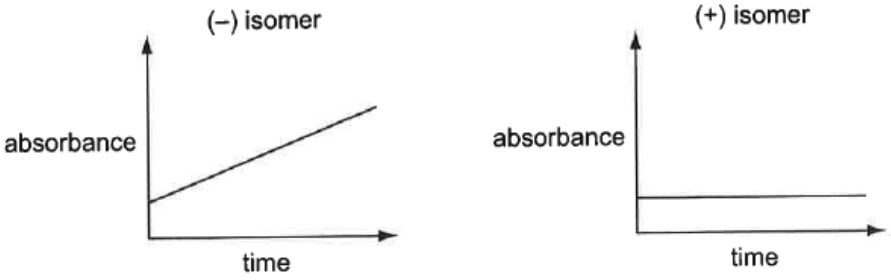
4 Lactic dehydrogenase catalyses the conversion of lactic acid as shown in the following equation.



Two forms (isomers) of lactic acid exist, (-) and (+), as shown below.



Reduced NAD absorbs ultraviolet light. NAD does not. The activity of bacterial lactic dehydrogenase on two different isomers of lactic acid was compared. The absorbance of ultraviolet light was measured using an ultraviolet spectrophotometer. The graphs show the results.



What can be concluded about bacterial lactic dehydrogenase?

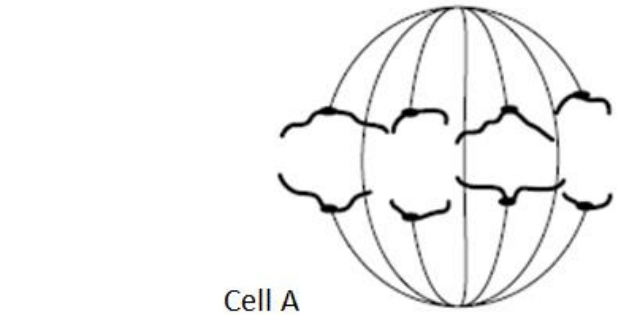
A Molecules of both isomers fit the active site.

B Molecules of neither isomer fit the active site.

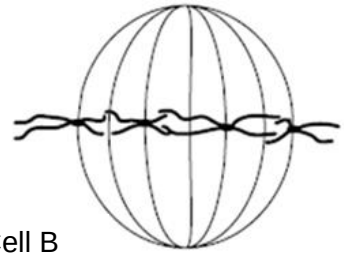
C The enzyme is specific to the (-) isomer.

D The enzyme is specific to the (+) isomer.

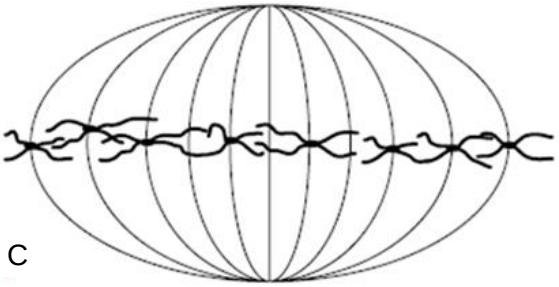
5 The figures below show cells obtained from various stages of nuclear division of a diploid organism. Cell A is undergoing anaphase II of meiosis.



Cell A



Cell B



Cell C

Cell D

Which statement correctly describes cells B to D?

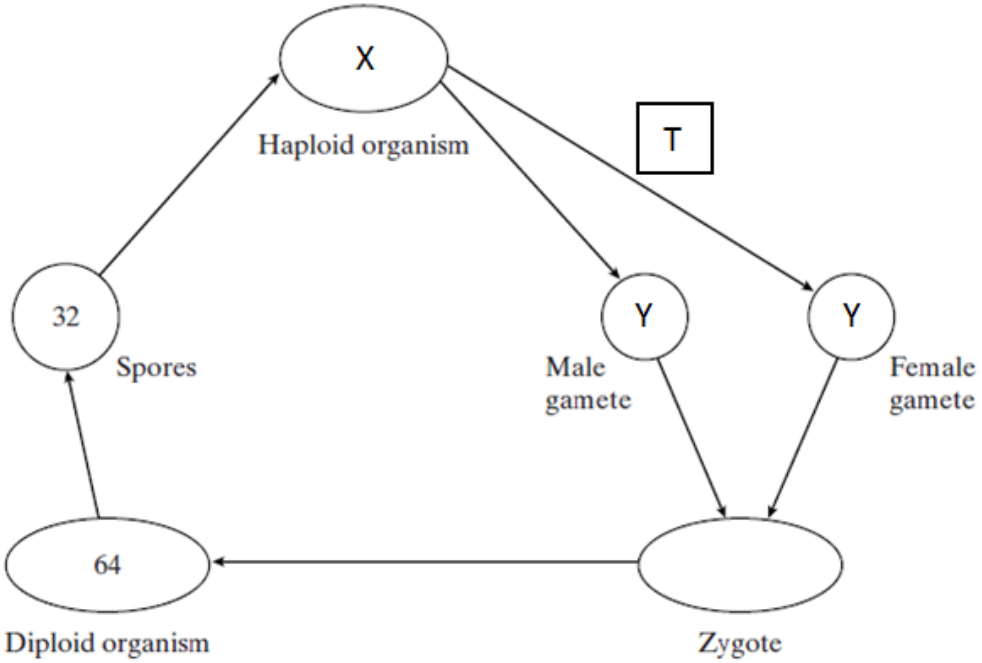
A Cell B is undergoing metaphase of mitosis.

B Cell C is obtained from a cell that has been treated with colchicine.

C Cells C and D are undergoing the same type of nuclear division.

D Cell D shows a diploid cell.

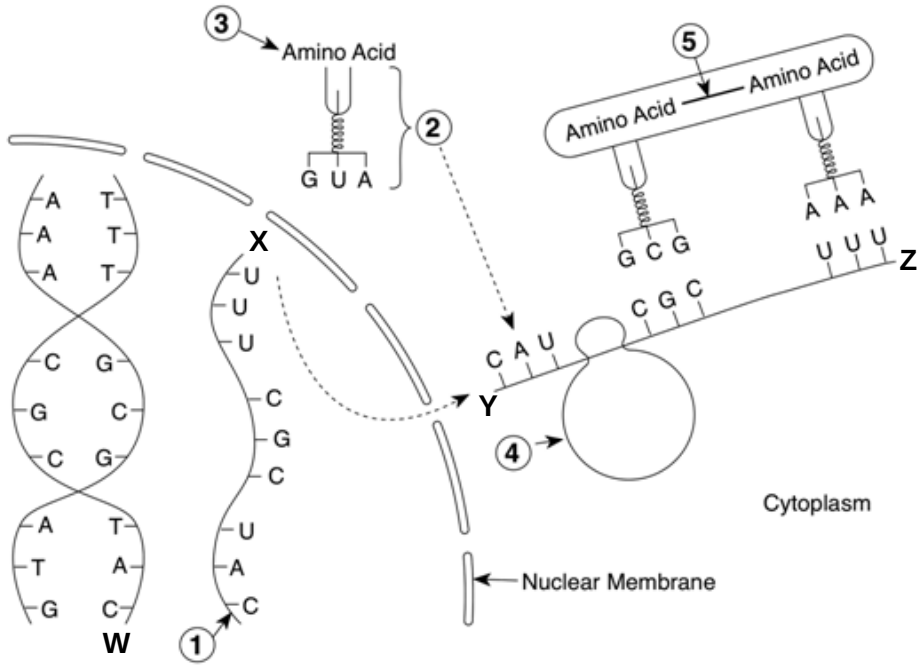
6 The diagram shows the life cycle of an organism. The numbers show how many chromosomes are present in one cell at each stage of the life cycle.



Which of the following correctly shows the type of division and number of chromosomes?

	Type of cell division	Number of chromosomes	
	T	X	Y
A	Mitosis	16	8
B	Meiosis	16	16
C	Mitosis	32	32
D	Mitosis	32	16

7 The diagram below represents some biochemical reactions involved in protein synthesis.



Which of the following is correct?

	Entire molecule coded directly from DNA is represented by	5' end of molecule	Enzyme involved in catalysing bond 5
A	1 and 2	**Z**	peptidyl transferase
B	1 and 2	**Y**	aminoacyl tRNA synthethase
C	1, 2 and 3	**X**	aminoacyl tRNA synthethase
D	1, 2 and 4	**W**	peptidyl transferase

8 Imagine that you discovered an organism which has DNA that contains two other nucleotide bases in addition to A, T, C and G. These two nucleotide bases form a base pair, so that the DNA contains six different bases which form three base pairs.

What would be the maximum number of amino acids that its DNA can code for, assuming that there are three stop codons and that there are three bases per codon?

A 15

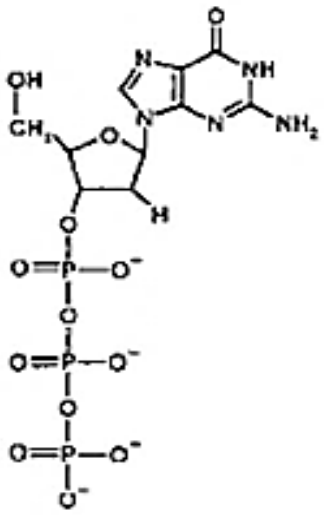
B 61

C 213

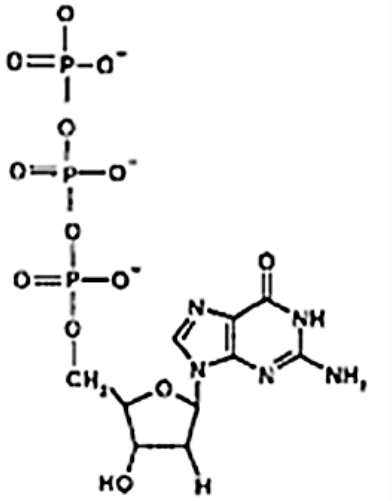
D 726

9 Which of the following is the correct physiological substrate for DNA polymerase?

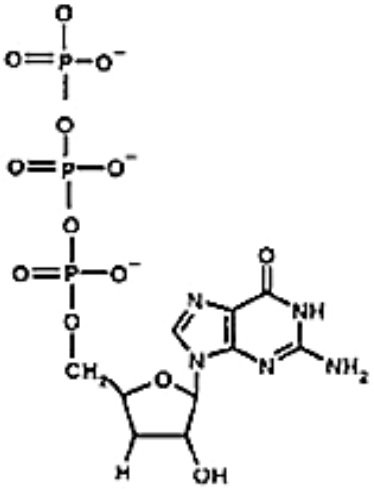
A



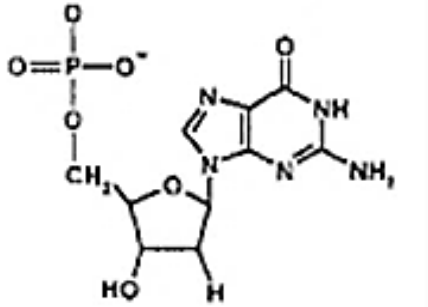
B



C



D



10 What protein would be coded by the following DNA molecule?

5' – CCTACTATGCGCCAGTATAAGTGACAATTA – 3'
3' – GGATGATACGCGGTCATATTCACTGTTAAT – 5'

Second Letter

1st letter	U	C	A	G	3rd letter
U	UUU Phe UUC UUA Leu UUG	UCU UCC UCA Ser UCG	UAU Tyr UAC UAA Stop UAG Stop	UGU Cys UGC UGA Stop UGG Trp	U C A G
C	CUU CUC Leu CUA CUG	CCU CCC Pro CCA CCG	CAU His CAC CAA Gln CAG	CGU CGC Arg CGA CGG	U C A G
A	AUU AUC Ile AUA AUG Met	ACU ACC Thr ACA ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA Arg AGG	U C A G
G	GUU GUC Val GUA GUG	GCU GCC Ala GCA GCG	GAU Asp GAC GAA Glu GAG	GGU GGC Gly GGA GGG	U C A G

A Met – Arg – Gln – Tyr – Lys

B Met – Arg – Gln – Lys – Lys

C Met – Lys – Arg – Gly – Gln – Lys – His – Arg

D Met – Ile – Arg – Gly – His – Ile – His – Cys

11 The genome of Ebola virus is a single-stranded RNA molecule whose sequence is complementary to the RNA sequence which functions as a viral messenger RNA.

Which of the following explains how capsomeres of the virus is synthesised?

A The genomic RNA is used for translation to produce capsomeres.

B mRNA is synthesised by reverse transcription of the genomic RNA which is then used for translation to produce capsomeres.

C RNA dependent RNA polymerase transcribes genomic RNA to mRNA which is used for translation to produce capsomeres.

D Genomic RNA reverse transcribed to dsDNA and integrates into the chromosome. Upon activation, the viral genes are transcribed to mRNA which is translated to capsomeres.

12 Which statement about bacteriophage is **false**?

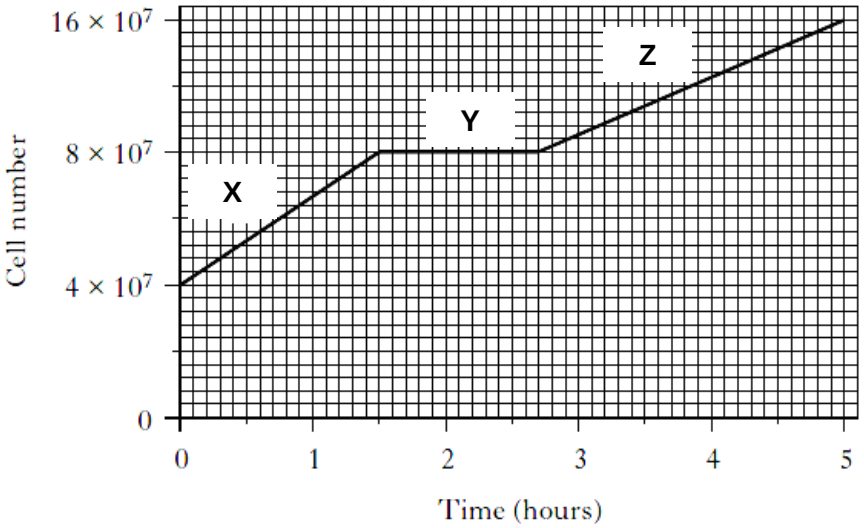
A Bacteriophages can reproduce via the lytic or lysogenic cycle, but not both.

B Bacteriophages are capable of undergoing genetic recombination.

C Temperate bacteriophages are not actively lytic.

D A prophage is replicated with the bacterial chromosome and passed to the two new daughter cells.

13 The graph below shows the growth of *E. coli* when introduced into a culture of medium containing glucose and lactose.



Which of the following is correct for the different parts of the graph?

	X	Y	Z
A	Lactose is used for the growth of the bacteria	Bacteria is in the latent state	Glucose used as respiratory substrate
B	Lactose is used for the growth of the bacteria	*Lac* repressor is inactivated	Mitotic division is occurring
C	Glucose is used for the growth of the bacteria	*Lac* repressor is activated	Mitotic division is occurring
D	Glucose is used for the growth of the bacteria	*Lac* repressor is inactivated	Lactose is being metabolised

14 A type of bacteria caused fatalities in human. These strains of bacteria possess genes for a toxin not found in the other harmless strains.

In an attempt to find out how these genes can be transferred between bacteria, several experimental set-ups were carried out. The results are shown in the table below.

Conditions	Results
DNA isolated from virulent strain and incubated with harmless strain.	Some virulent strains observed.
Virulent and harmless strains of bacteria incubated in a container with no barrier.	Some virulent strains observed.
Virulent and harmless strains of bacteria incubated in a container but separated by physical membrane barrier.	No virulent strain found in the side with harmless bacteria.

From the information provided only, which of the following gene transfer processes could have taken place?

I Transformation
II Conjugation
III Transduction

A **I** only

B **II** only

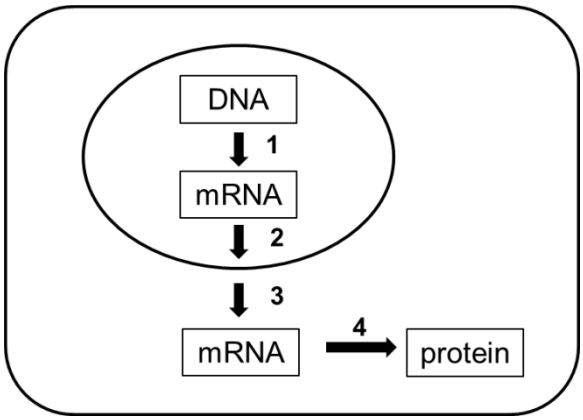
C **I** and **II** only

D All of the above

15 Which of the following shows the types of genetic changes that are **least** likely to have occurred to result in tumour cells?

	Proto-oncogene	Tumour suppressor gene
A	Gene amplification	Chromosomal deletion
B	Chromosomal translocation	Substitution mutation
C	Substitution mutation	Nonsense mutation
D	Nonsense mutation	Gene amplification

16 The diagram below shows the expression of a gene to its protein product in a eukaryotic cell.



Which of the following statement(s) is/are **false** with regards to gene expression in the above eukaryotic cell?

I Acetylation of histones can enable stage 1 to occur.

II Stage 1 does not take place when repressor binds to operator.

III Demethylation of DNA can enable stage 1 to occur.

IV 5' capping occurs in stage 2, and alternative splicing takes place in stage 3.

V During stage 4, mRNA is read in the 3' to 5' direction while the protein is formed in 5' to 3' direction.

A **I** and **III**

B **II** and **III**

C **II**, **IV** and **V**

D All of the above

17 Which of the following statement(s) about translation in a bacterium is/are true?

I Sigma factors bind to RNA polymerase, forming the holoenzyme complex to initiate translation.

II Polycistronic mRNA in *E. coli* has more than one Shine-Dalgarno sequence and each is recognised by ribosome.

III Polyribosomes are formed during translation, allowing more than one type of protein to be produced from a single mRNA template.

IV Polyadenylation signal sequence in the mRNA leads to translation termination.

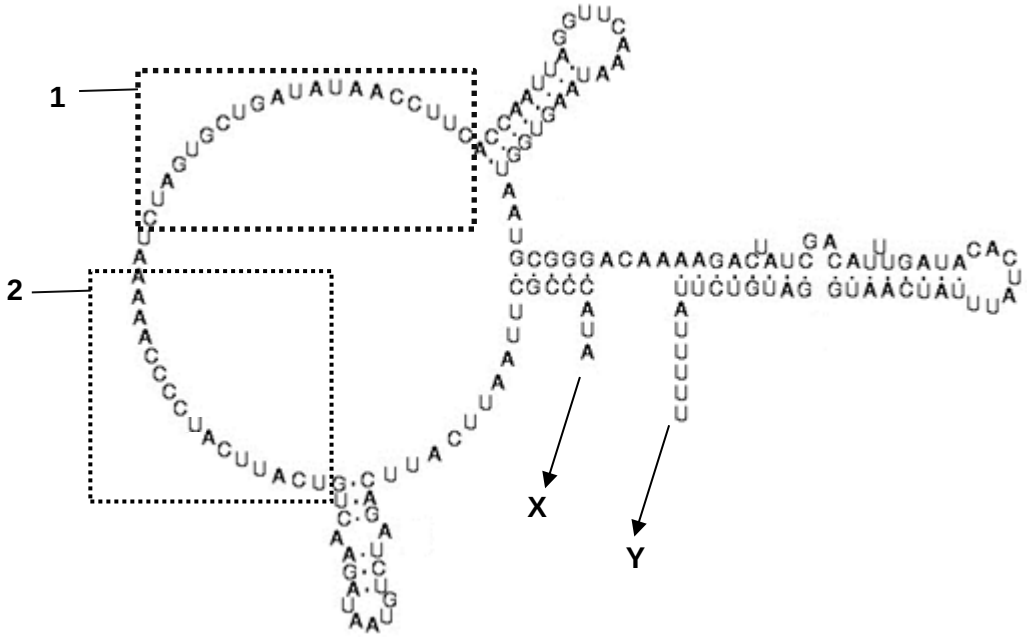
A **I** only

B **II** only

C **I** and **III**

D **II**, **III** and **IV**

18 The chromosomes found in the ciliate, *Tetrahymena*, are capped by telomeres with a repeat sequence of TTGGGG. The telomerase RNA of *Tetrahymena* is shown below.



Which of the following regarding *Tetrahymena* telomerase RNA is correct?

	Region where RNA template is located	5' end	3' end
A	1	X	Y
B	2	X	Y
C	1	Y	X
D	2	Y	X

19 In rats, the allele of a gene for 'mottled' coat (**M**) and the recessive allele (**m**) for 'normal' coat are sex linked. The allele of a gene for 'long' whiskers (**W**) and the recessive allele (**w**) for 'short' whiskers are autosomal.

A male rat with a normal coat and short whiskers was mated on several occasions to the same female. The offspring showed the following phenotypes in equal proportions:

- mottled females and males with long whiskers
- mottled females and males with short whiskers
- normal females and males with long whiskers
- normal females and males with short whiskers

What are the genotypes of the parents?

A X^mYww and X^MX^MWW

B X^mY^mww and X^MX^MWw

C X^mY^mww and X^MX^mWW

D X^mYww and X^MX^mWw

20 The shape oval or round, of a type of fruit is controlled by a pair of alleles at one gene locus. The gene for the colour of the fruit, red or yellow, is at a different locus. The genes are not linked.

A pure breeding plant with oval, red fruit is crossed with a pure breeding plant with round, yellow fruit. All the offspring have oval, orange fruit.

Which phenotypic ratio would you expect if these plants with oval, orange fruit were selfed?

A 1: 1: 1: 1

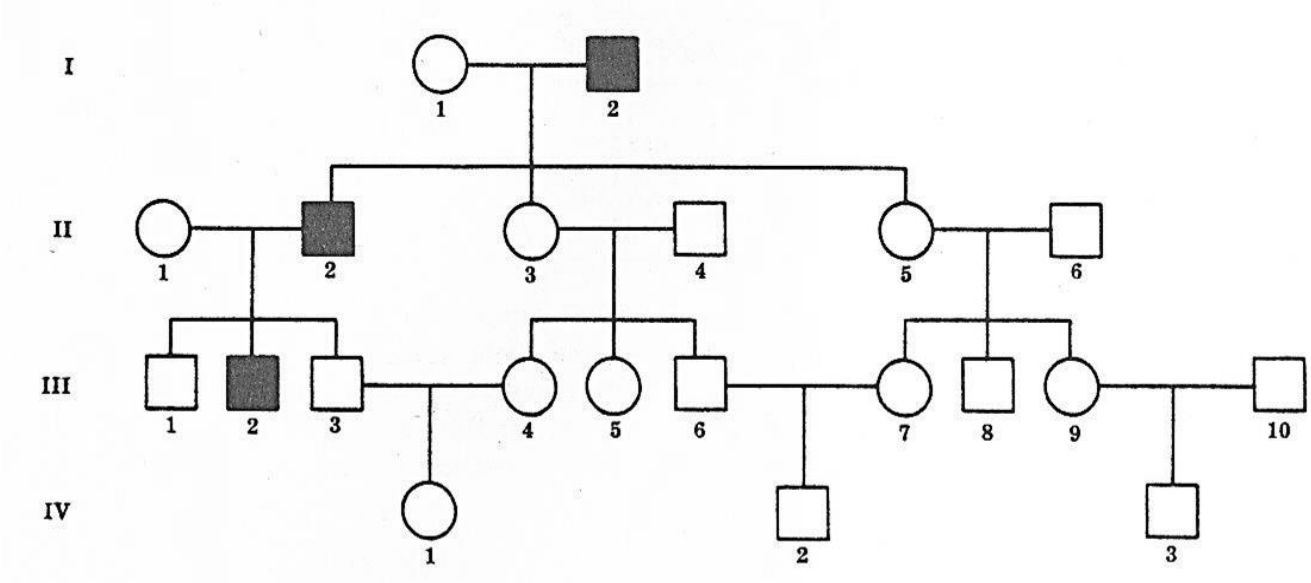
B 6: 3: 3: 2: 1: 1

C 9: 2: 2: 2: 1

D 9: 3: 3: 1

21 A recessive allele **r** is largely responsible for the development of red hair in humans. Dark hair is largely due to its dominant allele **R**.

In the hypothetical family pedigree below, unless there is evidence to the contrary, assume that individuals who marry into this family **do not** carry the **r** allele. Solid symbols represent red hair and open symbols represent dark hair.



What is the probability of red hair appearing in children from the hypothetical marriage of individuals with same genotype as **III-3** and **III-9**?

A 1/4

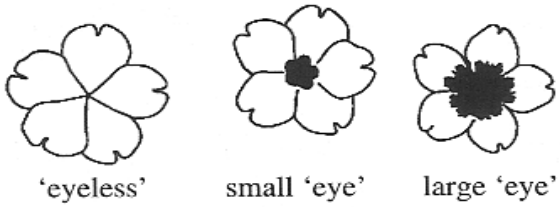
B 1/8

C 1/2

D 3/8

Use the following information for the questions **22** and **23.**

22 The flowers of a species of *Primula* may have a yellow 'eye' in the centre of the flower or they may be 'eyeless'. The 'eye' may be small or large as shown below.



These phenotypes are produced by **three** alleles of a gene. Allele $\mathbf{A^S}$ suppresses yellow pigment production in the 'eye', giving 'eyeless' flowers. Allele $\mathbf{A^S}$ is dominant to allele $\mathbf{A^R}$, which restricts the size of the 'eye', resulting in flowers with small 'eyes'. Both $\mathbf{A^S}$ and $\mathbf{A^R}$ are dominant to allele **a**.

Which of the following correctly shows the phenotype and all corresponding genotypes of the flower?

	Phenotype	**All possible genotypes**
A	'eyeless' flowers	$\mathbf{A^SA^S}$; $\mathbf{A^Sa}$
B	'small-eyed' flowers	$\mathbf{A^RA^R}$
C	'eyeless' flowers	$\mathbf{A^SA^S}$; $\mathbf{A^Sa}$; $\mathbf{A^RA^S}$
D	'large-eyed' flowers	$\mathbf{A^RA^S}$

23 In such a cross between plants with genotypes **A^Sa and A^Ra,** the following numbers of phenotypes of offspring were recorded. The phenotypic ratio of such a cross is 1 small-eyed : 2 eyeless : 1 large-eyed.

Phenotype of flower	Number of offspring
'eyeless'	85
'small-eyed'	59
'large-eyed'	56

Use the chi-squared (χ^2) test and the table of probabilities to find the probability of the results of this cross departing significantly by chance from expectation.

χ^2 test $\quad \chi^2 = \Sigma \frac{(O-E)^2}{E} \quad \nu = c - 1$

key to symbols

Σ = 'sum of . . .' $\quad$ O = observed 'value'
ν = degrees of freedom $\quad$ E = expected 'value'
c = number of classes

degrees of freedom	probability, p				
	0.10	0.05	0.02	0.01	0.001
1	2.71	3.84	5.41	6.64	10.83
2	4.61	5.99	7.82	9.21	13.82
3	6.25	7.82	9.84	11.35	16.27

What conclusion can you make from the chi-squared (χ^2) test?

A At level of significance of 5%, calculated χ^2 = 4.59, p > 0.05, there is no significant difference between observed and expected and the difference is due to chance.

B At level of significance of 5%, critical χ^2 value= 5.99, p < 0.05, there is a significant difference between observed and expected and the difference is not due to chance.

C At level of significance of 5%, calculated χ^2 = 4.59, p < 0.05, there is a significant difference between observed and expected and the difference is not due to chance.

D At level of significance of 5%, critical χ^2 value= 5.99, p > 0.05, there is a significant difference between observed and expected and the difference is not due to chance

24 Huntington's disease (HD), previously known as Huntington's chorea is a rare inherited neurological disorder affecting up to almost 8 people per 100,000. HD is caused by a single dominant allele of a gene. The disease's most obvious symptoms are abnormal body movements called chorea and a lack of coordination. It also affects a number of mental abilities and some aspects of personality. These physical symptoms commonly become noticeable in a person's forties.

Which of the following is true about the inheritance of HD?

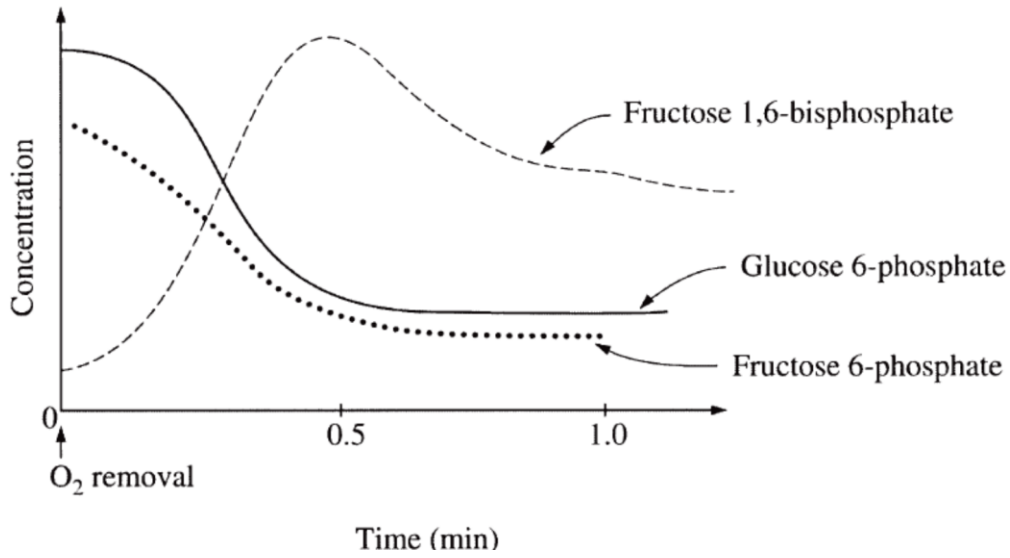
A As long as one of the parents has HD, all the offspring will have HD.

B The severity of disease follows a normal distribution.

C The phenotypic expression of HD is also dependent on the environment, that is, the symptoms only appear when the person has aged to 40 years.

D No offspring of two normal individuals will have HD.

25 Muscle cells were incubated in the presence of oxygen. Concentrations of various metabolites were measured immediately following the removal of oxygen. The results are shown below:



The change in the concentration of glucose 6-phosphate can be best explained by

A increased demand for ATP in the cells.

B increased rate of glycolysis.

C decreased synthesis of glucose 6-phosphate.

D increased enzymatic inhibition by fructose 1,6-bisphosphate.

26 The concentration of carbon dioxide in a sample of air was found to be 280 ppm (parts per million). A controlled experiment was designed to measure the concentration of carbon dioxide in the air after it had flowed over the leaves of a green plant. Measurements were taken at a range of light intensities.

Light intensity (% of full sunlight)	Concentration of carbon dioxide in air after flowing over leaves (ppm)
75	253
50	252
25	254
10	280

Which one of the following statements is **incorrect**?

A In the dark, concentration of carbon dioxide in the air after it had flowed over leaves would be at least 280 ppm.

B At the lower light intensities tested, rate of photosynthesis is limited by light intensity.

C At the higher light intensities tested, the rate of photosynthesis is affected by factors other than light.

D At a light intensity of 10% of full sunlight, photosynthesis does not occur.

27 Some photosynthetic organisms contain chloroplasts that lack photosystem II that are able to survive. The best way to detect the lack of photosystem II in these organisms would be

A to test for carbon fixation in the dark.

B to test for liberation of oxygen in the light.

C to test for presence of starch.

D to determine if they have thylakoids in the chloroplasts.

28 A common neurotransmitter is acetylcholine (ACh), which excites the post-synaptic neurone. Reduced levels of ACh in the brain synapses have been linked to Alzheimer's disease. A number of other chemicals also act at synapses. The table outlines some of the chemicals and their actions.

Chemical	Source in nature	Effect at synapse
Botulinum	*Clostridium* bacterium	Prevents release of ACh from the pre-synaptic membrane
Eserine	African calabar bean	Inhibits acetylcholinesterase
Curare	South American plant *Chondrondendron* sp.	Blocks post-synaptic receptors
Nicotine	Tobacco plant	Stimulates in the same way as ACh

Based on the information, a possible treatment for Alzheimer's disease is to

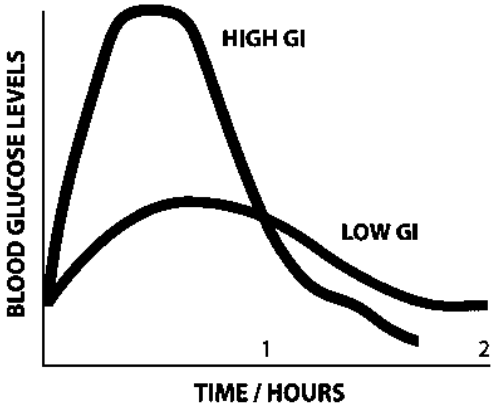
A administer eserine as a drug.

B inject curare into the patient's central nervous system.

C recommend the patient to stop smoking.

D purposely infect the patient with *Clostridium.*

29 Glycemic Index (GI) is a measurement on carbohydrate-containing foods and their impact on the blood sugar. The graphs show the impact of eating high GI food as compare to low GI food.



Which of the following is the most likely response to eating high and low GI foods?

A Level of insulin released by eating high GI food is higher than eating low GI resulting in more adipose cells taking in glucose.

B Level of insulin released by eating high GI food is the same as eating low GI food but takes longer time for blood glucose to reach set point.

C Level of glucagon released by eating high GI food is lower than eating low GI food resulting in more glucose stored as glycogen in the muscle.

D Level of glucagon released by eating high GI food is the same as level of insulin released as both works antagonistically to bring blood glucose back to set point.

30 In 1954, copper waste in the Finniss River in Australia killed numerous fish. This caused various species in the area to die out. However, one species, the black-banded rainbow fish, increased in numbers. The black-banded rainbow fish have modified gills that enable the fish to filter and remove the copper before it enters their body.

With respect to the black-banded rainbow fish it is reasonable to conclude that

A a mutation occurred in their population in 1954.

B the ability of their gills to remove copper already existed in 1954.

C the high levels of copper in the water changed the structure of their modified gills.

D their genomes are identical with those of the other species of fish that existed in 1954.

31 Sympatric speciation develops reproductive isolation without

A barrier to mating.

B geographical barrier.

C barrier to gene flow.

D genetic change.

32 Scientists found two different fossils in the same layer of rock. Both had limb-like appendages. As they had analogous structures, then they must have shared very similar

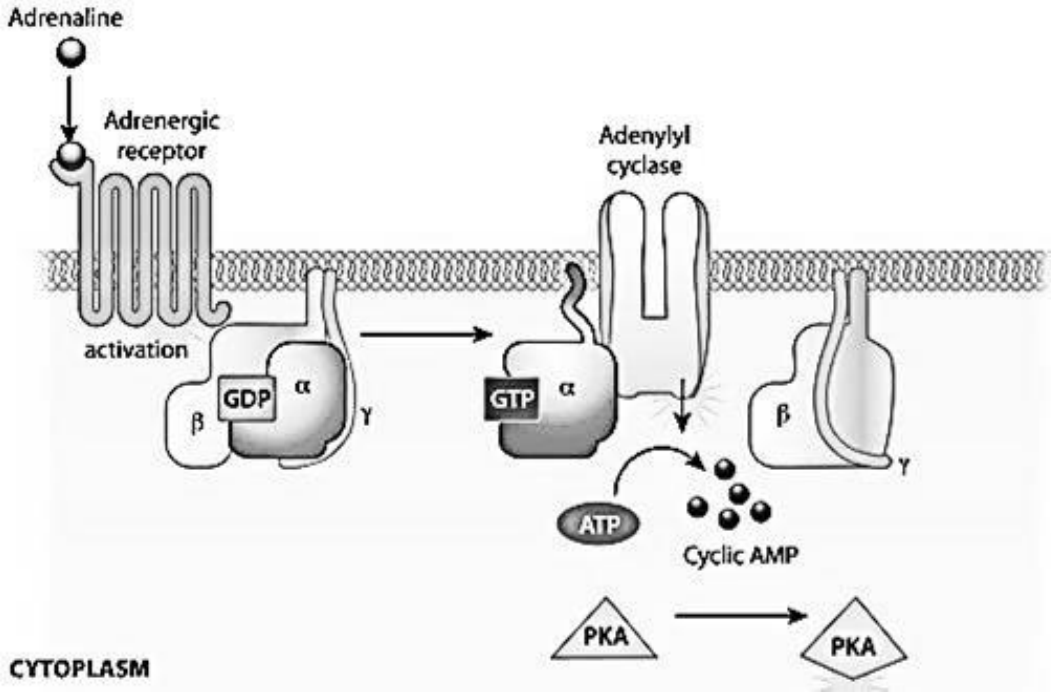
A DNA sequences.

B arrangement of bones in the appendages.

C habitats.

D selection pressures.

33 The following diagram shows the activation of the G protein-coupled receptor (GPCR) by the binding of adrenaline to the receptor. A mutation leads to constitutive signal transduction.



Which of the following is a possible explanation of the mutation?

A Conformational change in adenylyl cyclase such that it cannot convert ATP to cyclic AMP.

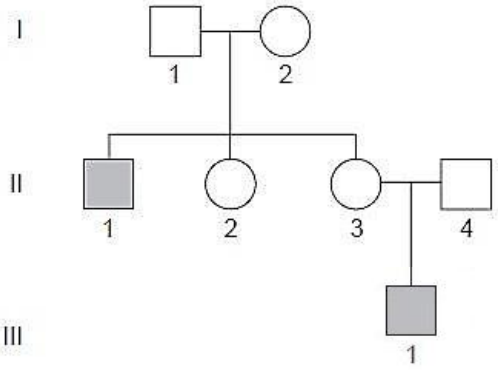
B Adrenaline cannot bind to the receptor.

C Cyclic AMP cannot bind to PKA.

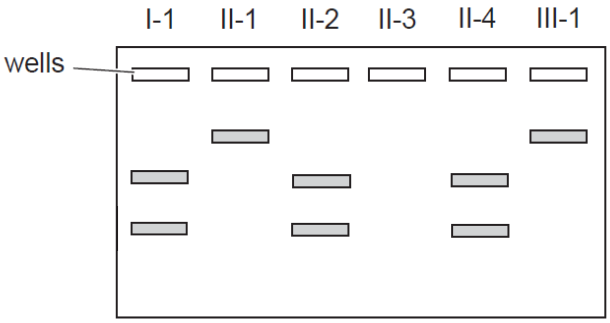
D GTPase in G protein fails to hydrolyse GTP to GDP.

34 Menkes' Disease in humans is characterised by sparse and wiry hair, growth failure and deterioration of the nervous system. Onset of the Menkes' syndrome usually occurs during infancy.

A family in which this X-linked disorder was present, underwent Restriction Fragment Length Polymorphism (RFLP) analysis using gel electrophoresis. The family pedigree is shown below.

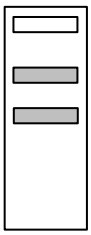


The RFLP analysis resulted in the following distribution of bands in the gel.

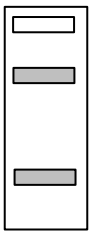


What would be the band pattern of individual II-3?

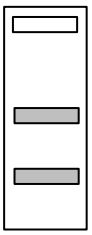
A



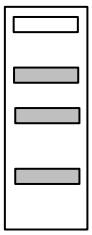
B



C



D



35 Which of the following options correctly describe the events occurring in each process?

	Action of restriction enzyme	**Ligation**	**Annealing**	**Denaturation**
A	Breaking of hydrogen bonds	Formation of hydrogen bonds	Formation of phosphodiester bonds	Breaking of phosphodiester bonds
B	Breaking of hydrogen bonds	Formation of hydrogen bonds	Formation of phophodiester bonds	Formation of phosphodiester bonds
C	Breaking of phosphodiester bonds	Formation of phosphodiester bonds	Formation of hydrogen bonds	Breaking of hydrogen bonds
D	Breaking of phosphodiester bonds	Formation of phosphodiester bonds	Breaking of hydrogen bonds	Formation of hydrogen bonds

36 The DNA sequences of the normal and mutated versions of a gene are shown below.

Normal DNA sequence:
GAGAATCCTTGAGCTCTTAAGCTTATT

Mutated DNA sequence:
GAGAATCCTTGAGGTCTTAAGCTTATT

The table below shows the recognition sequences of four restriction endonucleases.

Restriction endonuclease	**Recognition site**
*Bam*HI	GGATCC
*Eco*RI	GAATTC
*Hin*dIII	AAGCTT
*Sac*I	GAGCTC

Which of the restriction endonucleases would produce different number of fragments when used to digest normal and mutant DNA?

A *Bam*HI

B *Eco*RI

C *Hin*dIII

D *Sac*I

37 The human genome project has identified and mapped the genes on human chromosomes. This allows scientists to identify specific, faulty genes which contribute to inherited conditions. This is useful in many ways, for example:

1 carriers of faulty genes can be advised about changes in lifestyle to minimise risks.
2 carriers of faulty genes can be identified and informed of their risk status.
3 diagnostic tests can be developed to identify carriers of faulty genes.
4 drugs can be developed to block the action of problem genes.
5 embryos can be screened to avoid the birth of affected children.
6 employers can take into account the genetic predisposition of employees.

Which two uses arise **directly** from the information provided by the project?

A **1** and **2**

B **2** and **5**

C **3** and **4**

D **5** and **6**

38 Which of the following statements describe the possible outcomes in a gene therapy trial?

1 Therapeutic DNA replaces defective DNA.
2 Therapeutic DNA inserts in defective DNA.
3 Therapeutic DNA inserts randomly in the chromosomes.
4 Therapeutic DNA did not transform cells at all.

A **1** and **2**

B **2** and **3**

C **2, 3** and **4**

D All of the above

39 A research laboratory wishes to produce a line of embryonic stem cells. Which quantitative test should be used to determine if these cells are considered embryonic stem cells?

A Level of transcription factors.

B Level of telomerase.

C Number of active genes.

D Number of promoters in developmental genes.

40 According to the producers of the genetically modified salmon, the meat

A contains trace levels of ocean pout growth hormone.

B looks and tastes the same as unmodified salmon.

C has higher nutritional quality.

D can be frozen for longer periods of time.

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