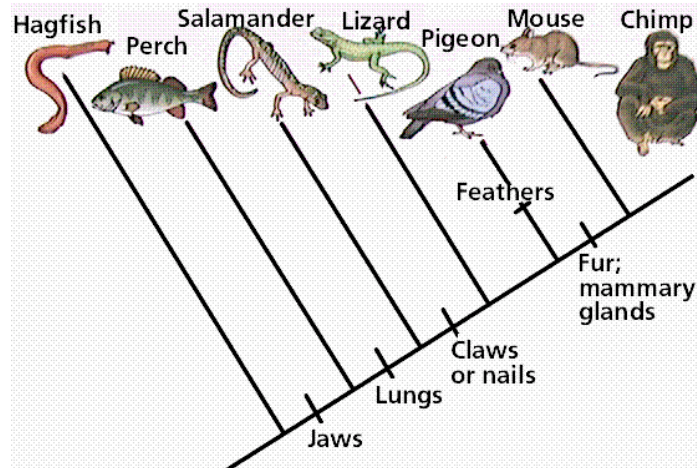


The following information relates to Questions 62 and 63

The diagram shows one model of the evolution of the subphylum Vertebrata.

**Question 62**

This diagram shows the sequence in which certain body structures evolved. Which structure appeared first?

- A. feathers
- B. mammary glands
- C. jaws
- D. claws or nails

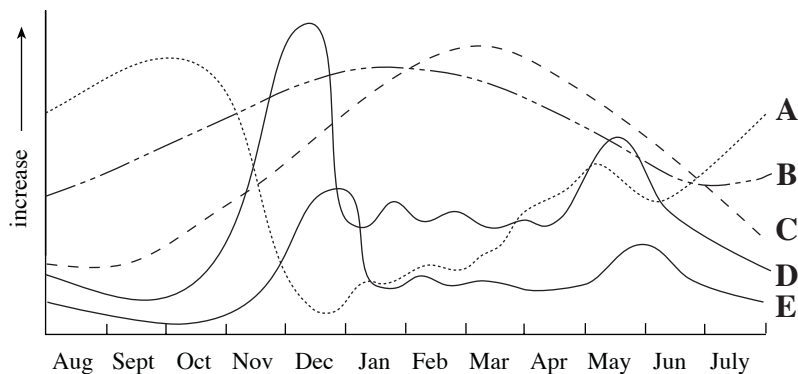
Question 63

Of the organisms listed, which first evolved lungs?

- A. Hagfish
- B. Salamander
- C. Lizard
- D. Perch

The following information relates to Questions 64 and 65

The graphs A – E show changes in phytoplankton (drifting photosynthetic organisms), zooplankton (floating animals), temperature, and light intensity in a New Zealand lake. All are drawn to different vertical scales.

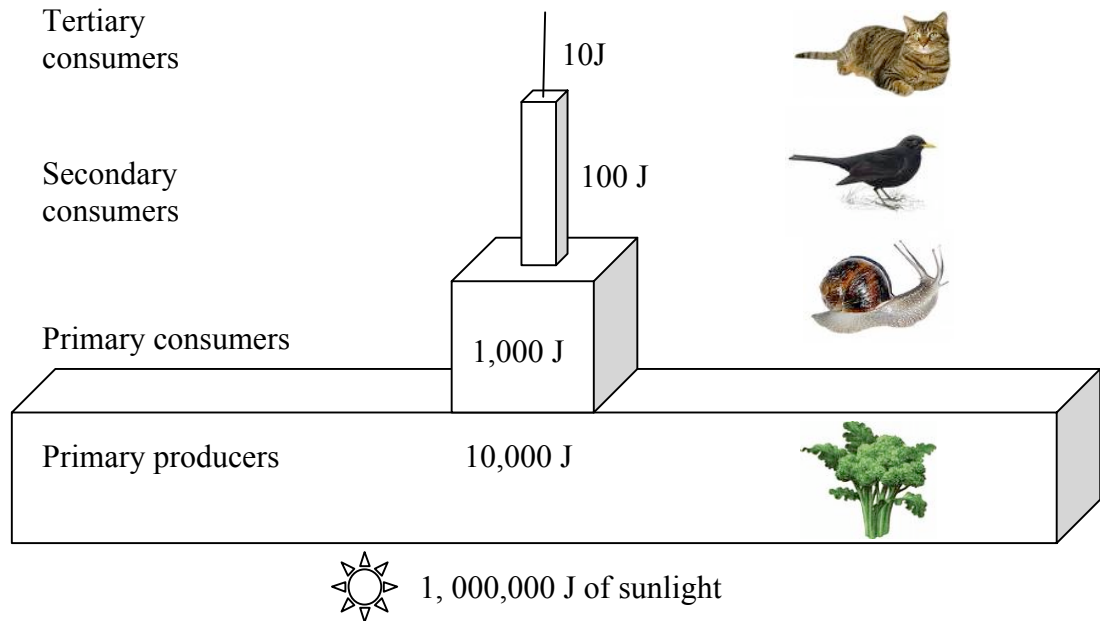
**Question 64**

Which graph shows changes in water temperature?

Question 65

Which graph shows changes in phytoplankton?

Question 66



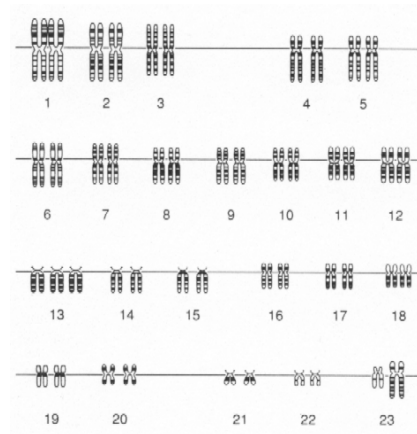
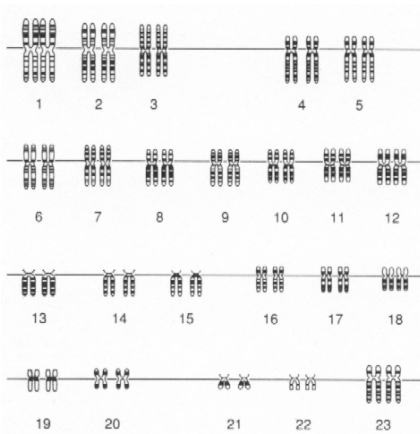
The idealised pyramid of net production above implies that:

- A. The most efficient transfer of energy is from producers to primary consumers.
- B. Most of the energy in a trophic level is incorporated into the next trophic level.
- C. As energy is transferred from one trophic level to another, about 10% of the energy is lost.
- D. Only about 10% of the energy is transferred from one trophic level to another.

Question 67

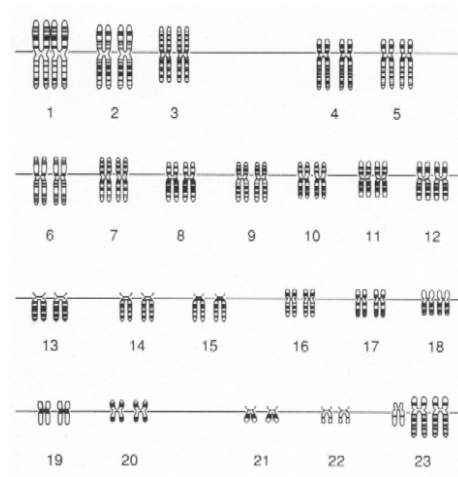
Chromosomal mutations may occur during meiosis when gametes (egg and sperm) are formed. Instead of the homologous chromosomes separating, with one going to each daughter cell, it is possible for both chromosomes to go in one direction and go to one gamete and for none to go into the other gamete. This process is called non-disjunction and can result in eggs or sperm that have an extra chromosome of a particular type (addition) or who lack a particular chromosome (deletion). The results for the offspring produced from a gamete carrying such a chromosome mutation are always marked and harmful.

Compare the normal female karyotype (below left) with the karyotype from a male individual with Patau syndrome (below right).



The table below shows some of the more common chromosomal mutations in humans.

Syndrome name	Clinical Symptoms	Chromosome Affected	Mutation Type
Polyploidy	Fatal	Extra complete set of chromosomes	Addition
Patau syndrome	Polydactyly, low set ears, cleft lip and palate, heart defects, mental retardation.	13	Addition
Edwards syndrome	Facial abnormalities incl. cleft lip and palate, mental retardation, fatal in the first few years of life.	18	Addition
Down syndrome	Characteristic facial features, short stature, heart defects, mental retardation.	21	Addition
Klinefelter syndrome	Male sex organs but abnormally small testes, sterility, breast enlargement.	23	Addition
Turner syndrome	Apparently female but sterile, require hormone therapy for the development of secondary female characteristics	23	Deletion



The individual with the karyotype shown at right suffered from which chromosomal mutation?

- A. Edwards syndrome
- B. Down syndrome
- C. Klinefelter syndrome
- D. Turner syndrome

Question 68

State the sex chromosome makeup of an individual with the syndrome above.

- A. XXY
- B. XY
- C. XO
- D. XX

Question 69

In addition to their role in determining sex, the sex chromosomes have genes for many characters that are unrelated to sex. A gene located on a sex chromosome is called a sex-linked gene. Red-green colour-blindness is a sex-linked trait that is due to a recessive allele on the X chromosome. What is the probability that a male who is colour-blind will pass this disorder onto his sons?

- A. 0
- B. $\frac{1}{2}$
- C. $\frac{1}{4}$
- D. 1

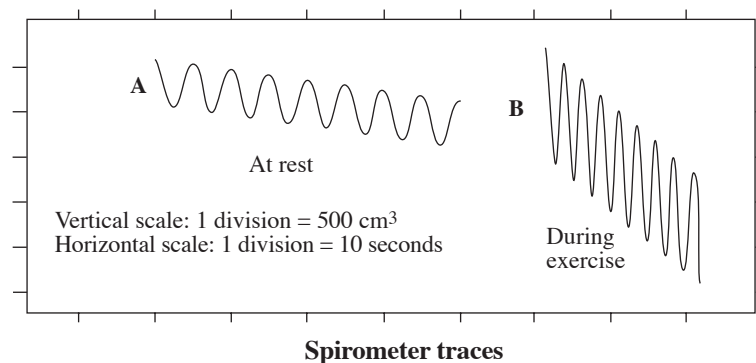
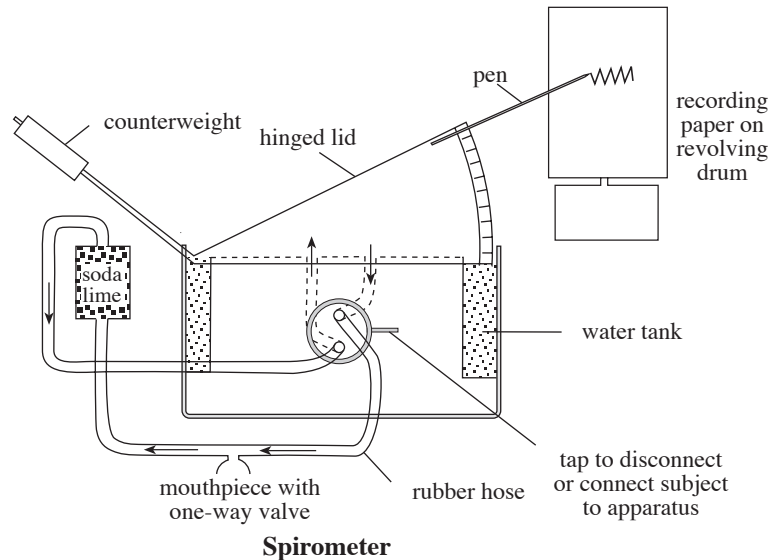
Question 70

A red-green colour-blind man with Klinefelter syndrome has parents with normal vision. The cause of this must have been non-disjunction in

- A. meiosis I in the mother.
- B. meiosis I in the father.
- C. meiosis II in the mother.
- D. meiosis II in the father.

The following information applies to Questions 71 – 72

A spirometer is used to record human breathing movements and oxygen consumption (see diagram). The person breathes into and out of an air tank floating on water, causing it to rise and fall. Attached to the air tank is a lever with a pen on the end, and as it rises and falls it makes a trace on paper wrapped round a slowly revolving drum. The tank is normally filled with pure oxygen, and the CO_2 produced by the subject is removed by soda lime. The mouthpiece is fitted with a one-way valve so that the airflow is unidirectional. The traces in the lower half of the figure were obtained for the same person, at rest and during exercise.

**Question 71**

As a result of exercise, the volume of air breathed in and out each minute increases by a factor of

- A. two
- B. three
- C. four
- D. five

Question 72

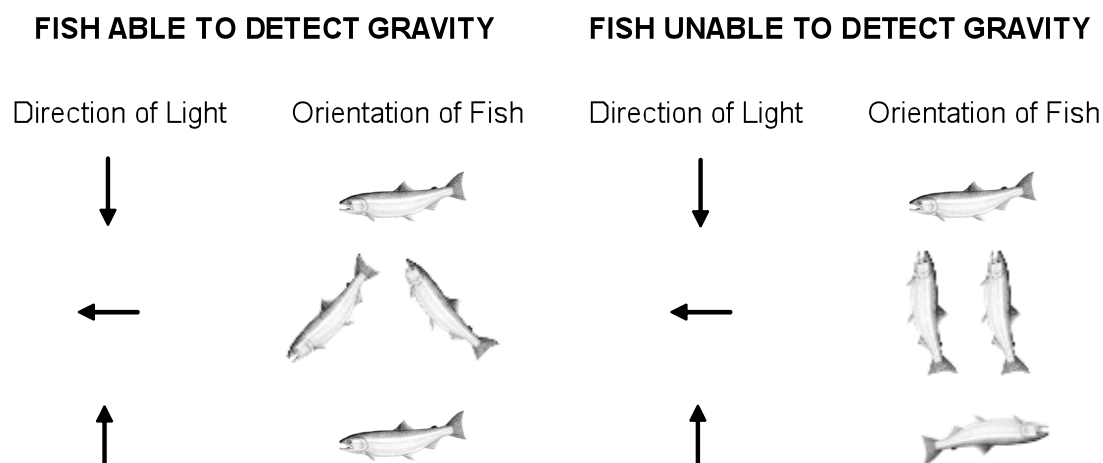
As a result of exercise, the rate of oxygen consumption increases by a factor of approximately

- A. two
- B. three
- C. four
- D. five

The following information applies to Questions 73 – 74

An experiment was carried out to investigate the cues used in orientation in salmon, *Salmo trutta*. The direction of light was manipulated in two groups of salmon.

The diagrams show the results of the experiment.

**Question 73**

What happens when the fish is unable to detect gravity?

- A. The fish swims horizontally.
- B. The fish swims with its dorsal fin pointing towards the light.
- C. The fish swims in circles.
- D. The fish swims with its dorsal fin pointing upwards.

Question 74

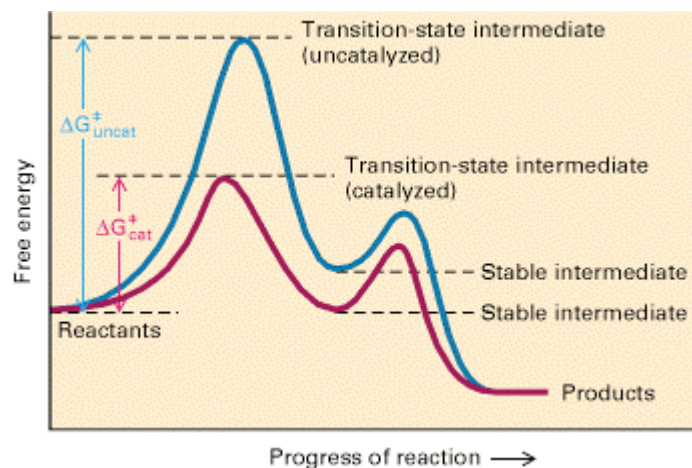
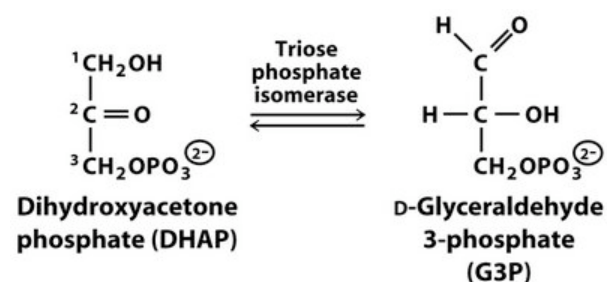
Which of the following statements is supported by the results of this investigation?

- A. Salmon cannot orient towards the light when they are unable to detect gravity.
- B. The light sensors of the salmon are on the lower surface of the fishes body.
- C. The response to gravity is more important than the response to light in the orientation of salmon.
- D. Salmon cannot detect light from below.

Question 75

Enzymes are protein catalysts that speed up reactions. The reaction shown below is one that occurs as part of the glycolysis pathway. In this reaction, one molecule of DHAP is converted to one molecule of G3P, and vice versa (the reaction is readily reversible). The reaction is catalysed by an enzyme called triose phosphate isomerase (TPI). As the reaction proceeds, there will be a point when neither DHAP or G3P exists. Instead, there will be a transition state whose structure is somewhere in between that of the product and the substrate. Stable intermediates may also be formed.

The graph below shows the energy changes occurring during this reaction.



Which of the following statements can be concluded from the diagram.

- A. TPI decreases the amount of transition-state intermediate formed.
- B. TPI decreases the amount of reactant required.
- C. TPI must be present for DHAP to be converted into G3P.
- D. TPI decreases the amount of energy required for this reaction to occur.

Question 76

The human body needs to maintain blood glucose (blood sugar) levels within a very narrow range, 70 mg/dl and 110 mg/dl. This regulation is achieved by two hormones produced by different cells in the pancreas.

Cell Type	Hormone produced	Target tissues	Action	Result
alpha cells	glucagon	liver	release of glucose stored in the liver cells	increased blood sugar levels
beta cells	insulin	muscle, red blood cells and fat cells	fat cells absorb glucose out of the blood	decreased blood sugar levels

During exercise blood sugar levels decrease as energy is used by the muscles. In order to return the blood sugar level to normal

- A. alpha cells would produce glucagon and glucose is released from the liver cells.
- B. alpha cells would produce glucagon and glucose would be absorbed from the blood.
- C. beta cells would produce insulin and glucose would be released from the liver cells.
- D. beta cells would produce insulin and glucose would be absorbed from the blood.

The following information applies to Questions 77 – 78

An antigen-antibody reaction where cells clump together and form visible aggregates is called agglutination. Hemagglutination is a method of determining a person's blood type based on an agglutination reaction. The ABO blood-group antigens, are glycoproteins expressed on red blood cells. These molecules determine whether a person's blood type is A, B, AB, or O. Determining a person's blood type has very important clinical applications. A person who is blood type A has antibodies against blood type B, while a person who has blood type O has antibodies against both A and B. A person with a blood type AB has neither antibodies against A nor B. If a person with blood type A gets a blood transfusion of type B blood, a fatal agglutination reaction will occur and the blood cells will be lysed.

Consider the table of hemagglutination reactions below (right).

Question 77

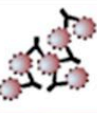
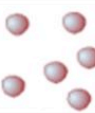
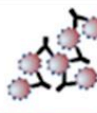

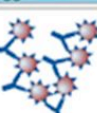


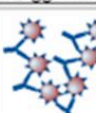
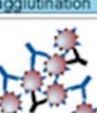


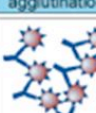

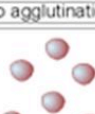


Which one of the blood groups can receive a blood transfusion from any of the other groups in case of emergency?

- A. A
- B. B
- C. AB
- D. O

Question 78

Which one of the blood groups can donate blood to any of the other blood types in case of emergency?

- A. A
- B. B
- C. AB
- D. O

Hemagglutination				
red blood cells from individuals of type				
serum from individuals of type	AB	O	B	A
A Anti B antibodies	 agglutination	 no agglutination	 agglutination	 no agglutination
B Anti A antibodies	 agglutination	 no agglutination	 no agglutination	 agglutination
O Anti A + B antibodies	 agglutination	 no agglutination	 agglutination	 agglutination
AB no antibodies to A or B	 no agglutination	 no agglutination	 no agglutination	 no agglutination

Question 79

A count was made of the number of cells showing different stages of mitosis in an onion root tip. The results were as shown below.

Stage	Percentage of total number of dividing cells
Prophase	85.0
Metaphase	7.7
Anaphase	2.9
Telophase	4.4

The best explanation of these data is that

- A the area investigated was very close to the root tip.
- B the sample used for the count was statistically too small.
- C the division process was just starting.
- D prophase takes much longer than the other stages.

Question 80

Animals can be classified as ectotherms or endotherms on the basis of how they manage their heat budgets. Ectotherms gain most of their heat from the environment whereas endotherms use metabolic heat to regulate their body temperature.

A study of young, 30 cm-long alligators in Florida showed that they had a high and relatively stable body temperature. How could you decide whether an alligator is ectothermic or endothermic?

- A. It has a high and stable body temperature so it is an ectotherm.
- B. In shady conditions a young alligator's body temperature is the same as that of the ambient air, but in sunshine its body temperature may be several degrees higher than that of the ambient air. You conclude it is an ectotherm.
- C. You conclude the alligator is an ectotherm because it is not a bird or a mammal.
- D. You note that the body temperature of the alligator matches the environment and therefore conclude that the alligator is an ectotherm.