TYCHR
Friend, Philosopher, Guide

IB Biology HL Paper 3 Question Bank

WWW.TYCHR.COM

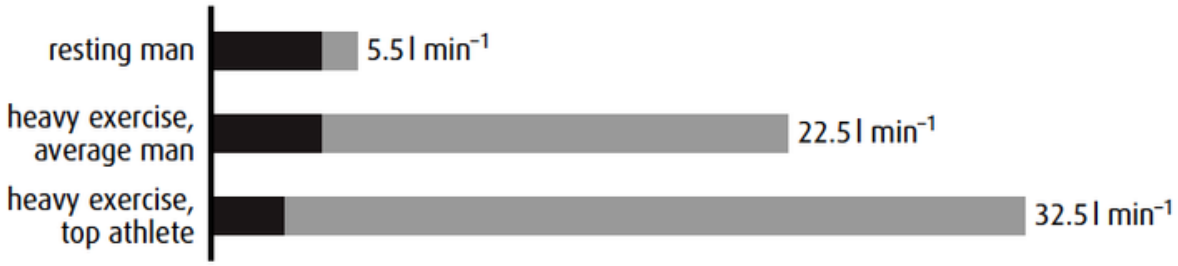
TYCHR
Friend, Philosopher, Guide

IB Biology HL Paper 3 Question Bank

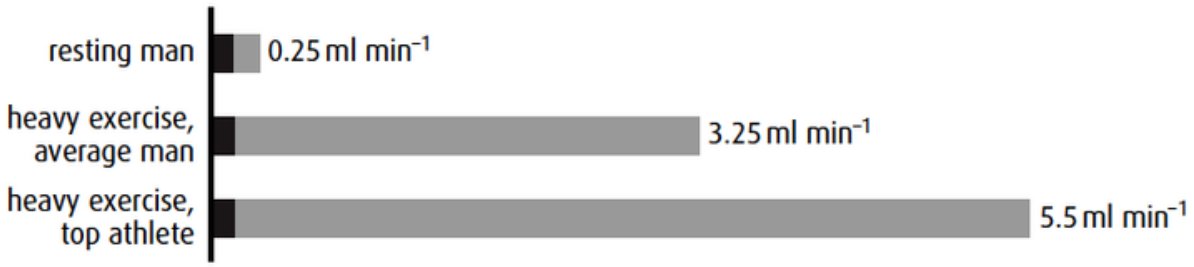
SECTION-A

1. During muscular activity, the heart must deliver more blood to the tissues due to increased oxygen demand. Graph 1 shows the distribution of total blood flow (cardiac output) between muscles (gray-shaded bars) and all other parts of the body (black-shaded bars) in resting men and in both average men and top athletes doing heavy exercise. Graph 2 shows oxygen consumption by the muscles and all other parts of the body in the three groups. The value given for each bar represents the total body values.

Graph 1: Cardiac output / (litres) l min^{-1}



Graph 2: Oxygen consumption / (millilitres) ml min^{-1}



source: Schmidt-Nielsen, K (1987) *Animal Physiology: Adaptation and Environment*, Cambridge University Press, pp148–149

IB Biology HL Paper 3 Question Bank

SECTION-A

A. Describe the relationship between exercise and total cardiac output.
Directly proportional

B. (i) Calculate the percentage of cardiac output to the muscles for an average man during heavy exercise as compared to the total body value.
82.5 (±3)%

(ii) Calculate the increase in total oxygen consumption (ml min-1) for a top athlete during heavy exercise as compared to a resting man.
5.25

C. Using the data, explain how training affects an athlete's body with respect to cardiac output and oxygen consumption.
Cardiac output to muscles / overall cardiac output increases. More in top athletes / with training. Training / top athletes decrease cardiac output to the rest of the body. Training increases oxygen consumption in muscles/ overall oxygen consumption during heavy exercise.

IB Biology HL Paper 3 Question Bank

SECTION-B

1. Explain the role of feedback mechanisms in maintaining homeostasis in the human body.

Feedback mechanisms play a crucial role in maintaining homeostasis in the human body. Homeostasis is the process by which the body maintains stable internal conditions, such as body temperature, pH levels, and blood glucose levels. Feedback mechanisms involve monitoring changes in internal conditions and adjusting physiological processes to maintain stable conditions.

Negative feedback mechanisms are the most common type of feedback mechanisms in the human body. These mechanisms work to reverse or reduce changes in internal conditions. An example of negative feedback is the regulation of blood glucose levels. When blood glucose levels rise, the pancreas releases insulin, which stimulates cells to take up glucose from the blood, reducing the blood glucose levels. This decrease in blood glucose levels reduces the stimulus for insulin release, leading to a decrease in insulin secretion. As a result, blood glucose levels are maintained within a narrow range.

Positive feedback mechanisms, on the other hand, amplify changes in internal conditions. Although they are less common than negative feedback mechanisms, they are important for specific physiological processes. An example of positive feedback is the process of blood clotting. Once a clot starts to form, it triggers the release of more clotting factors, leading to the formation of a larger clot until the bleeding stops.

2. Explain the principles of genetic engineering and how it has been used to produce insulin.

Genetic engineering is a powerful tool that allows scientists to manipulate the DNA of organisms in order to create new traits or modify existing ones. The principles of genetic engineering involve identifying the gene of interest, isolating and cloning the gene, inserting it into the host organism's DNA, and allowing the organism to express the gene. One application of genetic engineering is the production of insulin. Insulin is a hormone that regulates blood sugar levels, and is normally produced by the pancreas. However, in people with type 1 diabetes, the pancreas does not produce enough insulin, and they need to inject insulin to manage their blood sugar levels.

IB Biology HL Paper 3 Question Bank

SECTION-B

To produce insulin, scientists isolate the human insulin gene, which codes for the production of insulin, and then insert it into bacteria or yeast cells. These cells act as "factories" that produce human insulin. The process involves several steps, including the creation of a recombinant DNA molecule, which contains the human insulin gene and the bacterial or yeast DNA, and the introduction of this DNA into the host cell using various techniques, such as transformation or electroporation.

Once the recombinant DNA is introduced into the host cell, the cell is grown in a culture, and the insulin is extracted and purified from the culture medium. This process has revolutionized the production of insulin, as it allows for the large-scale production of human insulin at a lower cost than extracting it from animal sources. It has also enabled the development of new forms of insulin, such as rapid-acting insulin analogs, which have improved the treatment options for people with diabetes. The principles of genetic engineering have been applied to many other areas of biotechnology, and have the potential to provide solutions to a wide range of challenges in fields such as medicine, agriculture, and environmental science.

3. Discuss the factors that affect the rate of photosynthesis in plants.

Photosynthesis is a complex process that is essential for the growth and survival of plants. The rate of photosynthesis can be affected by a number of factors, including light intensity, temperature, and the concentration of carbon dioxide. Light intensity is one of the most important factors affecting the rate of photosynthesis. As light intensity increases, so does the rate of photosynthesis, until the plant reaches its maximum rate of photosynthesis. Beyond this point, increasing light intensity has no further effect on the rate of photosynthesis.
Temperature is another important factor that affects the rate of photosynthesis. Most plants have an optimal temperature range for photosynthesis, usually between 20°C and 30°C. At temperatures below this range, the rate of photosynthesis decreases due to a lack of enzyme activity, while at temperatures above this range, the rate of photosynthesis decreases due to enzyme denaturation.
The concentration of carbon dioxide is also a key factor that affects the rate of photosynthesis. As the concentration of carbon dioxide increases, the rate of photosynthesis increases, until the plant reaches its maximum rate of photosynthesis. Beyond this point, increasing the concentration of carbon dioxide has no further effect on the rate of photosynthesis.

IB Biology HL Paper 3 Question Bank

SECTION-B

Other factors that can affect the rate of photosynthesis include water availability, nutrient availability, and the presence of pollutants or toxins. Water is essential for photosynthesis, and plants that are water-stressed may have a reduced rate of photosynthesis. Similarly, plants that are nutrient-deficient may also have a reduced rate of photosynthesis.

In conclusion, the rate of photosynthesis in plants is affected by a range of factors, including light intensity, temperature, and the concentration of carbon dioxide. Understanding these factors is important for optimizing plant growth and productivity, and for developing sustainable agricultural practices.

4. Explain the process of DNA replication, and how it ensures the fidelity of genetic information transfer during cell division.

DNA replication is the process by which a cell makes an exact copy of its DNA before cell division. The process is essential for ensuring that the genetic information contained in the original DNA molecule is accurately passed on to the daughter cells. The process of DNA replication involves several steps.

First, the double helix of DNA must be unwound by a special enzyme called helicase. This creates a replication fork, which is the site where the replication of DNA will occur. Next, an enzyme called primase synthesizes a short RNA primer on each of the DNA strands, providing a starting point for DNA synthesis.
Once the primers have been added, an enzyme called DNA polymerase can start the actual process of DNA synthesis. DNA polymerase adds nucleotides to the growing DNA strand in a 5' to 3' direction. The new strand is synthesized in a complementary fashion to the template strand, ensuring that the two strands of the original DNA molecule remain complementary.
As the DNA polymerase adds nucleotides to the growing strand, it checks for errors and corrects any mistakes it encounters. This proofreading function ensures that the new DNA molecule is an exact copy of the original.

Finally, once the new DNA strands have been synthesized, an enzyme called ligase seals any gaps in the backbone of the DNA molecule to create a continuous, double-stranded molecule. This completes the process of DNA replication, and ensures that the genetic information contained in the original DNA molecule is accurately transferred to the daughter cells during cell division.

IB Biology HL Paper 3 Question Bank

SECTION-B

In conclusion, DNA replication is a complex process that ensures the accurate transfer of genetic information from parent cells to daughter cells during cell division. The process involves multiple steps, including unwinding the DNA helix, adding RNA primers, synthesizing new DNA strands, and proofreading and correcting errors. By ensuring the fidelity of DNA replication, cells can maintain the integrity of their genetic information across multiple generations.

5. Discuss the role of enzymes in biochemical reactions, and provide an example of an enzyme-catalyzed reaction.

Enzymes are essential biological catalysts that play a critical role in the regulation of biochemical reactions in living organisms. Enzymes are proteins that accelerate the rate of chemical reactions without being consumed in the process. They achieve this by lowering the activation energy required for a reaction to occur, thereby increasing the rate of the reaction.

Enzymes function by binding to specific substrates, or reactant molecules, at their active sites. This binding initiates a series of chemical reactions that ultimately result in the conversion of the substrate to a product. The specific shape of the enzyme's active site is crucial to its ability to catalyze a particular reaction. The active site is highly specific and recognizes only one or a few closely related substrate molecules.

An example of an enzyme-catalyzed reaction is the breakdown of lactose by lactase. Lactose is a disaccharide made up of glucose and galactose, and is found in milk and other dairy products. Lactase is an enzyme that specifically catalyzes the hydrolysis of lactose into its component monosaccharides, glucose and galactose.

The lactase enzyme binds to the lactose molecule at its active site, where it breaks the glycosidic bond between the glucose and galactose molecules. This results in the release of glucose and galactose as separate monosaccharides. Without the lactase enzyme, lactose would be indigestible in humans, and would pass through the digestive tract undigested.

IB Biology HL Paper 3 Question Bank

SECTION-B

6. Describe the different types of muscle tissue in animals, and compare and contrast their structure and function.

In animals, there are three types of muscle tissue: skeletal, smooth, and cardiac. Each of these types of muscle tissue has a unique structure and function that allows them to perform specific tasks within the body.
Skeletal muscle tissue is the most abundant muscle tissue in the body, and it is responsible for voluntary movement. It is attached to bones by tendons and is under conscious control.

Skeletal muscle fibers are long, cylindrical cells that contain multiple nuclei and are striated, meaning they have a striped appearance when viewed under a microscope. These striations are caused by the regular arrangement of contractile units called sarcomeres. Skeletal muscles are capable of generating large amounts of force and are designed for endurance, making them ideal for activities such as running and weightlifting.

Smooth muscle tissue is found in the walls of internal organs, such as the stomach, intestines, and blood vessels. It is responsible for involuntary movement and is not under conscious control. Smooth muscle cells are spindle-shaped and have a single nucleus. They lack the striations seen in skeletal muscle tissue and instead have a smooth appearance. Smooth muscle cells are capable of sustained contractions, making them ideal for tasks such as regulating blood pressure and moving food through the digestive tract.

Cardiac muscle tissue is found only in the heart and is responsible for pumping blood throughout the body. It is also an involuntary muscle tissue and is not under conscious control. Cardiac muscle cells are cylindrical, branched, and contain a single nucleus. Like skeletal muscle tissue, cardiac muscle tissue is striated due to the presence of sarcomeres. However, the cells are connected by intercalated discs that allow for coordinated contraction of the heart muscle. Cardiac muscle cells are capable of generating a lot of force over a long period, making them ideal for maintaining the continuous pumping action of the heart.

7. Explain the process of transcription and translation, and how they lead to the synthesis of proteins.

IB Biology HL Paper 3 Question Bank

SECTION-B

Transcription and translation are two key processes involved in the synthesis of proteins in cells. Transcription is the process by which genetic information encoded in DNA is copied into RNA molecules, while translation is the process by which the sequence of nucleotides in RNA molecules is translated into the sequence of amino acids in proteins.

The process of transcription begins with the binding of an enzyme called RNA polymerase to a specific region of DNA called the promoter. Once bound, RNA polymerase separates the two strands of DNA and begins to synthesize a complementary RNA molecule using one of the DNA strands as a template. The resulting RNA molecule is complementary to the DNA strand from which it was transcribed, except that RNA uses uracil instead of thymine. Once the RNA polymerase reaches the end of the DNA sequence, it stops and releases the newly synthesized RNA molecule.

The newly synthesized RNA molecule, also known as messenger RNA (mRNA), is then transported from the nucleus to the cytoplasm, where it interacts with ribosomes during the process of translation. Translation involves the use of transfer RNA (tRNA) molecules, each of which has a specific amino acid attached to one end and a sequence of three nucleotides, called an anticodon, at the other end. The anticodon of a tRNA molecule binds to a complementary codon on the mRNA molecule, allowing the corresponding amino acid to be added to the growing chain of amino acids in a protein.

The sequence of codons on the mRNA molecule determines the sequence of amino acids in the protein. The process of translation begins when a ribosome recognizes the start codon on the mRNA molecule and binds to it. The ribosome then moves along the mRNA molecule, reading each codon and adding the corresponding amino acid to the growing protein chain. This process continues until the ribosome encounters a stop codon on the mRNA molecule, at which point it releases the newly synthesized protein and disassembles.

8. Describe the structure and function of the plasma membrane.

IB Biology HL Paper 3 Question Bank

SECTION-B

The plasma membrane is a thin, selectively permeable layer that surrounds the cell and separates its internal environment from the external environment. It is composed of a lipid bilayer made up of phospholipids, which have hydrophilic heads and hydrophobic tails. The phospholipids are arranged in a way that the hydrophobic tails face inward, forming a nonpolar region that prevents the movement of polar molecules across the membrane. The hydrophilic heads, on the other hand, face outward, interacting with water molecules on both sides of the membrane.

The plasma membrane also contains various types of proteins, which are embedded in the lipid bilayer or attached to its surface. These proteins serve several functions, including transport of molecules across the membrane, cell signaling, and structural support. Some proteins, known as transport proteins or channels, provide specific pathways for the movement of molecules across the membrane. Others, such as receptors, bind to signaling molecules and trigger intracellular responses.
The plasma membrane is also involved in regulating the movement of molecules in and out of the cell. It does so through several mechanisms, including passive transport, active transport, and facilitated diffusion.

9. Describe the process of meiosis, and how it leads to the formation of genetically diverse gametes in sexually reproducing organisms.

Meiosis is a type of cell division that occurs in sexually reproducing organisms, and it results in the production of haploid cells (cells with half the number of chromosomes as the original cell). This process consists of two rounds of cell division, meiosis I and meiosis II, and it involves several key steps.

During meiosis I, the DNA in the cell is replicated, and homologous chromosomes (pairs of matching chromosomes, one from each parent) come together and undergo a process called synapsis. This is followed by the exchange of genetic material between the homologous chromosomes, which is known as crossing over. This exchange of genetic material creates new combinations of genes, which contributes to genetic diversity. Next, the homologous chromosomes separate and move to opposite ends of the cell, resulting in two new cells with half the number of chromosomes as the original cell. This is known as reduction division.

IB Biology HL Paper 3 Question Bank

SECTION-B

During meiosis II, the sister chromatids (replicated copies of each chromosome) in each cell separate and move to opposite ends of the cell, resulting in the formation of four new haploid cells.
The end result of meiosis is the production of genetically diverse gametes, which are the reproductive cells that combine during fertilization to form a new organism. This genetic diversity is due to the combination of two key factors: crossing over during meiosis I, which results in the exchange of genetic material between homologous chromosomes.

The overall result of meiosis is the production of genetically diverse gametes with unique combinations of genetic material. This genetic diversity is essential for sexual reproduction as it allows for offspring with new combinations of traits and adaptations that may increase their chances of survival and reproductive success.

TYCHR

Friend, Philosopher, Guide

WWW.TYCHR.COM

+91 9540653900