# AQA (GCSE Notes)

## Chapter 6: Inheritance, Variation, and Evolution

**Q1. Explain how the number of chromosomes is reduced during meiosis.**

**Answer:** Meiosis reduces the number of chromosomes by half through two cell divisions. First, the parent cell copies its chromosomes. Then, in the first division, homologous chromosomes (one from each parent) are separated into two new cells. In the second division, the sister chromatids of each chromosome are separated. This results in four gametes, each with only one set of chromosomes (haploid), instead of two sets (diploid). This ensures that when gametes fuse during fertilisation, the correct number of chromosomes is restored.

**Q2. Why do offspring produced by sexual reproduction show variation?**

**Answer:** Offspring from sexual reproduction show variation because they inherit different combinations of genes from each parent. During meiosis, genetic information is shuffled through a process called crossing over, and the chromosomes are randomly distributed to gametes. As a result, each gamete is genetically unique. When two gametes combine during fertilisation, the mixing of genes creates individuals that are all genetically different from each other and their parents.

**Q3. Describe what happens to chromosomes during the formation of gametes.**

**Answer:** During the formation of gametes through meiosis, the chromosomes are first copied. The cell then goes through two divisions. In the first division, homologous chromosomes are separated into two cells. In the second division, sister chromatids are separated, resulting in four gametes. Each gamete ends up with half the original number of chromosomes and each is genetically different from the others. This ensures variation in sexually reproducing organisms.

**Q4. What is the role of meiosis in sexual reproduction?**

**Answer:** Meiosis plays a key role in sexual reproduction by producing gametes—sperm and egg cells—that have half the number of chromosomes. This is important because it ensures that when fertilisation occurs, the resulting zygote has the normal number of chromosomes. Meiosis also introduces genetic variation by mixing the genetic material through independent assortment and crossing over, which is important for the survival of the species.

**Q5. Compare the processes of mitosis and meiosis.**

**Answer:** Mitosis produces two identical cells for growth and repair, each with the same number of chromosomes as the original cell. Meiosis, however, produces four non-identical gametes, each with half the number of chromosomes. Mitosis involves one cell division, while meiosis involves two. Mitosis results in no variation, whereas meiosis creates genetic diversity, which is important in sexual reproduction and evolution.

**Q6. Why do gametes have half the number of chromosomes compared to body cells?**

**Answer:** Gametes have half the number of chromosomes so that when they join during fertilisation, the resulting zygote has the correct full number of chromosomes. This prevents the chromosome number from doubling with each generation. Meiosis ensures that gametes carry only one set of chromosomes. If gametes had the full number, the offspring would end up with too many chromosomes, causing problems in development.

**Q7. How does fertilisation restore the normal number of chromosomes in an organism?**

**Answer:** In fertilisation, a male gamete (sperm or pollen) and a female gamete (egg) combine. Each gamete has half the number of chromosomes. When they fuse, their chromosomes combine to form a full set in the zygote. This restores the normal diploid number of chromosomes. For example, in humans, each gamete has 23 chromosomes, and the zygote ends up with 46 chromosomes.

**Q8. What is a gamete, and how is it formed?**

**Answer:** A gamete is a sex cell—sperm in males and egg in females—that contains half the number of chromosomes of normal body cells. It is formed through meiosis, a special kind of cell division that occurs in the reproductive organs. During meiosis, the parent cell divides twice to produce four gametes, each with a unique combination of genes and half the original number of chromosomes.

**Q9. Why are gametes genetically different from each other?**

**Answer:** Gametes are genetically different due to the processes that happen during meiosis. Crossing over during the first division allows parts of chromosomes to swap between pairs, mixing genetic information. Also, when chromosomes are separated, they are randomly distributed into gametes. This means each gamete ends up with a different set of genes, which is why all gametes are unique and leads to variation in offspring.

**Q10. How does a zygote develop into an embryo?**

**Answer:** After fertilisation, the zygote contains a complete set of chromosomes. It begins to divide by mitosis to form more cells. These cells continue to divide and increase in number. As the group of cells grows, they begin to differentiate and form different types of tissues and organs. This developing structure is called an embryo. The embryo continues to grow and develop inside the uterus in animals or within a seed in plants.

**Q11. What is the purpose of mitosis after fertilisation?**

**Answer:** After fertilisation, mitosis helps the single-celled zygote grow into a multicellular organism. Mitosis produces identical cells, allowing the zygote to divide and increase in number. This process continues, forming tissues and organs. Mitosis also ensures that each new cell has the same genetic information as the zygote. It's essential for the growth, repair, and development of the embryo into a complete organism.

**Q12. Define the term 'clone' and explain how it is formed.**

**Answer:** A clone is an organism that is genetically identical to its parent. It is formed through asexual reproduction or artificial cloning techniques. In natural asexual reproduction, a single parent produces offspring by mitosis without the fusion of gametes. In artificial cloning, scientists may use methods like tissue culture or adult cell cloning to produce organisms with the exact same DNA as the original.

**Q13. Why does asexual reproduction produce identical offspring?**

**Answer:** Asexual reproduction involves only one parent and no mixing of genetic material. The offspring are produced by mitosis, which creates cells that are exact copies of the parent cell. As a result, all the genetic information is the same, and the offspring are genetically identical to the parent and to each other. This is why asexual reproduction leads to clones.

**Q14. Give two examples of organisms that reproduce asexually.**

**Answer:** One example is bacteria, which reproduce asexually by binary fission. Another example is strawberries, which reproduce using runners—horizontal stems that grow from the parent plant and develop into new plants. Both these methods involve no gametes and no genetic mixing, so the new organisms are clones of the parent.

**Q15. What is the main advantage of sexual reproduction over asexual reproduction?**

**Answer:** The main advantage of sexual reproduction is that it creates genetic variation in the offspring. This variation means that if the environment changes, some individuals may have characteristics that help them

survive better. Over time, these individuals are more likely to reproduce and pass on their genes, which is the basis of natural selection and evolution.

**Q16. What is the main disadvantage of asexual reproduction?**

**Answer:** The main disadvantage of asexual reproduction is that it does not produce variation. All the offspring are genetically identical, so if the environment changes or a disease spreads, the whole population could be affected in the same way. There may be no individuals with the characteristics needed to survive, which can lead to extinction.

**Q17. Explain how meiosis results in variation.**

**Answer:** Meiosis results in variation through two main ways. First, during crossing over in the first division, sections of DNA are exchanged between chromosome pairs, mixing genes. Second, when chromosomes are separated into gametes, they are randomly distributed, meaning each gamete gets a different combination of genes. These processes ensure each gamete is unique, leading to genetic variation in offspring.

**Q18. What is meant by the term 'differentiation' in embryo development?**

**Answer:** Differentiation is the process where unspecialised cells in the embryo change and become specialised to perform specific jobs. For example, some cells become nerve cells, while others become muscle or skin cells. This allows the embryo to develop into a fully functioning organism with all the different types of cells it needs to survive and grow.

**Q19. How does sexual reproduction lead to natural selection?**

**Answer:** Sexual reproduction creates genetic variation in a population. When the environment changes, some individuals may have inherited traits that give them an advantage. These individuals are more likely to survive, reproduce, and pass on their beneficial genes. Over many generations, this process—called natural selection—can lead to changes in the species and even the development of new species.

**Q20. Describe the process of fertilisation in animals.**

**Answer:** Fertilisation in animals occurs when a male gamete (sperm) joins with a female gamete (egg). This usually happens inside the female's body. The sperm swims toward the egg and fuses with it, combining their genetic material. This forms a single cell called a zygote, which has a full set of chromosomes. The zygote then begins to divide and grow into an embryo.

**Q21. Why is genetic variation important for the survival of a species?**

**Answer:** Genetic variation means individuals within a species are different from each other. This is important because if the environment changes, some individuals might have traits that help them survive. These individuals are more likely to live and pass on their genes. Without variation, all individuals might be affected in the same way, which could lead to extinction.

**Q22. Describe the role of pollen in the reproduction of flowering plants.**

**Answer:** In flowering plants, pollen contains the male gametes. It is transferred from the male part of a flower (anther) to the female part (stigma), either by wind, insects, or other animals. Once it reaches the stigma, the pollen grows a tube down to the ovule, allowing the sperm to reach and fertilise the egg. This forms a seed, which grows into a new plant.

**Q23. What happens to cells immediately after fertilisation?**

**Answer:** After fertilisation, the zygote begins to divide by mitosis. It produces more and more cells, all genetically identical. These cells form a ball of cells called an embryo. The cells then begin to specialise or differentiate, becoming the various tissues and organs needed for a fully developed organism.

**Q24. Why does asexual reproduction not involve gametes?**

**Answer:** Asexual reproduction only needs one parent and does not involve the fusion of male and female gametes. Instead, it uses mitosis to produce new organisms. Because there is no joining of different genetic material, the offspring are exact copies of the parent, which is why gametes are not involved.

**Q25. Describe one benefit of asexual reproduction in plants.**

**Answer:** One benefit of asexual reproduction in plants is that it is fast and allows the plant to produce many identical offspring quickly. For example, strawberry plants use runners to produce new plants. This is useful in stable environments where the parent plant is already well-suited to the conditions, allowing the species to spread rapidly.

**Q26. How does selective breeding rely on understanding reproduction and genetics?**

**Answer:** Selective breeding relies on knowing that characteristics are passed from parents to offspring through genes. By choosing parents with desired traits and breeding them, the likelihood increases that their offspring will inherit those traits. Over many generations, this results in animals or plants with improved features. Understanding reproduction and inheritance helps breeders predict which traits are most likely to appear in the offspring.

**Q27. Why are all cells produced by mitosis genetically identical?**

**Answer:** Cells produced by mitosis are genetically identical because the DNA is copied exactly before the cell divides. The process ensures that each new cell receives an identical set of chromosomes. Since there is no mixing or rearrangement of genetic material in mitosis, all daughter cells are clones of the parent cell, which is important for growth, repair, and maintenance of the body.

**Q28. What is the function of sperm and egg cells in animals?**

**Answer:** The function of sperm and egg cells is to carry genetic information from each parent and combine it during fertilisation. Sperm cells are male gametes and egg cells are female gametes. Each contains half the number of chromosomes, so when they fuse, they create a zygote with a complete set of genetic information. This process ensures that offspring have traits inherited from both parents.

**Q29. How is the genetic information copied before a cell divides during meiosis?**

**Answer:** Before meiosis begins, the cell makes a complete copy of its DNA. This means each chromosome is duplicated to form two identical sister chromatids joined at a point called the centromere. These copies ensure that even after two cell divisions, each gamete ends up with one complete set of chromosomes, though the combinations and gene arrangements are different, causing variation.

**Q30. Explain how cloning can be used to produce large numbers of plants with the same characteristics.**

**Answer:** Cloning in plants can be done using cuttings or tissue culture. In tissue culture, small groups of cells from a parent plant are grown in special conditions to form new plants. Since the cells come from one plant, they all have the same genetic material. This method is useful for quickly producing large numbers of identical plants with desirable traits, like disease resistance or good fruit quality.

**Q31. What is a mutation and how can it affect an organism?**

**Answer:** A mutation is a change in the DNA sequence of a gene. It can happen naturally during DNA

replication or be caused by factors like radiation. Mutations can have no effect, a small effect, or a large effect. Some mutations can change how a protein works, which may affect the organism's health, appearance, or behaviour. Occasionally, a mutation can be beneficial or harmful depending on the environment.

**Q32. How can a mutation lead to a genetic disorder?**
**Answer:** A mutation can lead to a genetic disorder if it changes the instructions for making a protein in a way that makes the protein faulty or missing. If the protein has an important role in the body, its absence or incorrect function can cause disease. For example, in cystic fibrosis, a mutation in a single gene affects the movement of salt and water in and out of cells, leading to thick mucus in the lungs.

**Q33. Why are most mutations harmful or neutral rather than beneficial?**
**Answer:** Most mutations are harmful or neutral because they disrupt the normal function of genes. DNA has evolved to work in a very specific way, so random changes often cause problems or make no useful difference. Beneficial mutations are rare because it's uncommon for a random change to improve how an organism functions. However, when beneficial mutations do occur, they can provide an advantage in survival.

**Q34. What is the link between mutation, variation, and evolution?**
**Answer:** Mutations are the source of genetic variation, which is the difference in DNA between individuals. This variation is important for evolution because it provides the raw material for natural selection. If a mutation gives an organism an advantage in its environment, it may survive and pass on the gene. Over time, these beneficial mutations can lead to the development of new traits or even new species.

**Q35. How can a beneficial mutation lead to increased fitness in an organism?**
**Answer:** A beneficial mutation can improve an organism's ability to survive or reproduce in its environment. For example, a mutation that helps an animal blend into its surroundings can make it less likely to be seen by predators. This gives it a better chance to survive and reproduce, passing the mutation to its offspring. Over generations, this trait may become common in the population, increasing its fitness.

**Q36. Explain why genetic modification is considered controversial.**
**Answer:** Genetic modification is controversial because people have concerns about its safety, ethics, and environmental effects. Some worry that eating genetically modified food could harm health, even though there is little evidence of this. Others are concerned about unexpected effects on ecosystems, like harming insects. There are also ethical questions about changing the genes of living things for human benefit.

**Q37. What is genetic engineering and how is it different from selective breeding?**
**Answer:** Genetic engineering is the process of directly changing the DNA of an organism by inserting genes from another organism. This can give the organism new traits quickly and precisely. In contrast, selective breeding involves choosing parents with desirable traits and mating them over generations. Genetic engineering is faster and more specific, while selective breeding takes longer and relies on natural variation.

**Q38. How can genes be transferred from one species to another?**
**Answer:** Genes can be transferred using genetic engineering techniques. First, enzymes are used to cut out the desired gene from one organism's DNA. The gene is then inserted into a vector like a plasmid or virus.

This vector carries the gene into the target organism's cells. If done at an early development stage, the organism will grow with the new gene and show the desired characteristic.

**Q39. Describe one example of a genetically modified organism and its benefit.**
**Answer:** One example is genetically modified (GM) corn. It has been modified to resist insects by producing a natural toxin that kills pests. This reduces the need for chemical pesticides, which can harm the environment. As a result, farmers get higher crop yields and can grow more food using fewer chemicals, which benefits both the environment and food production.

**Q40. Why might people be concerned about the use of genetically modified organisms?**
**Answer:** People may worry that GM organisms could have unknown effects on health or the environment. For example, genes from GM crops might spread to wild plants, or reduce the variety of wild species. Others fear that long-term effects of eating GM foods are not fully understood. Ethical concerns also arise, as some believe it's wrong to change an organism's genes for human purposes.

**Q41. How has understanding of meiosis helped in developing modern genetic technologies?**
**Answer:** Understanding meiosis has helped scientists understand how genes are passed on and how variation happens. This knowledge is used in genetic engineering to target specific genes and in cloning to ensure the right number of chromosomes is present. It also helps in embryo screening, gene therapy, and understanding inherited disorders. Without knowledge of meiosis, these technologies would not be possible.

**Q42. What is the role of modelling chromosomes in understanding meiosis?**
**Answer:** Modelling chromosomes helps students and scientists visualise how chromosomes are copied and separated during meiosis. These models show how genetic material is mixed and divided, helping explain how gametes get different combinations of genes. They are useful in understanding concepts like crossing over, independent assortment, and the reduction in chromosome number.

**Q43. Explain why all gametes from the same organism are not genetically identical.**
**Answer:** During meiosis, genetic material is shuffled through crossing over and independent assortment. Crossing over mixes genes between chromosome pairs, while independent assortment randomly distributes maternal and paternal chromosomes into gametes. Because these processes are random, each gamete ends up with a unique combination of genes, even though they come from the same parent organism.

**Q44. How does the fusion of gametes ensure diversity in offspring?**
**Answer:** Each gamete is genetically unique due to the way meiosis works. When two gametes—one from each parent—fuse during fertilisation, their different genetic material combines. This produces a zygote with a new mix of genes. This mix results in offspring that are different from both parents and from each other, increasing genetic variation in the population.

**Q45. What is the outcome of the two divisions that occur during meiosis?**
**Answer:** The first division separates homologous chromosomes, and the second separates sister chromatids. As a result, four gametes are formed, each with half the number of chromosomes and each genetically different. This is important for sexual reproduction because it maintains the chromosome number in the species and introduces variation in the offspring.

**Q46. Describe how a new plant can be produced from cloning.**
**Answer:** A new plant can be cloned using tissue culture or cuttings. In tissue culture, cells are taken from part of a plant and grown in special conditions. These cells divide and form new plants that are genetically identical to the parent. In cuttings, a piece of the parent plant is placed in soil or water, where it develops roots and grows into a new plant with the same DNA as the original.

**Q47. How can scientists ensure that a clone has the desired characteristics?**
**Answer:** Scientists select a parent organism that already has the desired traits. Since cloning creates genetically identical copies, the clone will also have those traits. Scientists also monitor the growth and health of the clone during development to check if it is developing correctly. If using tissue culture, they may test small samples before producing large numbers of clones.

**Q48. Why is meiosis important for maintaining chromosome number across generations?**
**Answer:** Meiosis halves the number of chromosomes in gametes, so that when fertilisation occurs, the full number is restored in the zygote. Without meiosis, the chromosome number would double with each generation, which would lead to problems in development. Meiosis ensures that each generation starts with the correct chromosome number, keeping the species stable.

**Q49. What is the relationship between chromosomes, genes, and DNA?**
**Answer:** DNA is a long molecule that carries genetic information. Genes are short sections of DNA that code for proteins. Chromosomes are structures made of tightly coiled DNA, found in the nucleus of cells. Each chromosome contains many genes. So, chromosomes carry DNA, and DNA contains genes, which control traits in organisms.

**Q50. Describe the difference in genetic information between cells formed by mitosis and meiosis.**
**Answer:** Cells formed by mitosis are genetically identical to the parent cell and to each other. They have the full number of chromosomes and the same genetic material. In contrast, cells formed by meiosis are gametes that have half the number of chromosomes. Each one is genetically different because of crossing over and independent assortment. This difference is essential for variation in sexual reproduction.

**Q51. Explain how variation in offspring can be an advantage in a changing environment.**
**Answer:** Variation in offspring means that individuals have different traits. If the environment changes, some individuals may have traits that help them survive better. These individuals are more likely to survive, reproduce, and pass on their traits. This increases the chances that at least some members of the species will survive, which helps the species continue over time even if conditions become difficult.

**Q52. Why does sexual reproduction require more time and energy compared to asexual reproduction?**
**Answer:** Sexual reproduction requires two parents to find and attract mates, which takes time and energy. In animals, this may involve movement, fighting, or courtship. In plants, it may involve producing flowers, nectar, or pollen. After mating, fertilisation must occur. These steps make sexual reproduction slower and more energy-demanding than asexual reproduction, which can happen quickly with just one parent.

**Q53. Describe how asexual reproduction allows rapid population growth under favourable conditions.**
**Answer:** Asexual reproduction does not require a mate, so one organism can produce many offspring quickly. Since the process is simple and fast, organisms like bacteria, fungi, and some plants can reproduce rapidly when conditions are good. All the offspring are clones, so if the parent is well-suited to the environment, so are the offspring. This helps the population grow quickly and fill the habitat.

**Q54. What are the benefits of producing many identical offspring in a short time?**
**Answer:** Producing many identical offspring quickly means the population can grow fast, especially when conditions are stable and favourable. Because all offspring are clones, they keep the successful traits of the parent. This is useful for farming and agriculture, where identical crops or animals with good traits are needed. It also helps some species survive by outcompeting others for space and resources.

**Q55. Explain how selective breeding can increase food production.**
**Answer:** Selective breeding allows farmers to choose animals or plants with the best traits, such as fast growth, high yield, or disease resistance. These are bred together, and their offspring inherit the good traits. Over many generations, this leads to crops and livestock that produce more food, are stronger, and are more efficient. This helps increase food supply and supports growing human populations.

**Q56. What is the main disadvantage of asexual reproduction in changing environments?**
**Answer:** The main disadvantage is that all offspring are genetically identical. If the environment changes and the parent's traits are no longer suitable, all the offspring may also struggle to survive. There is no variation to allow for adaptation, so the whole population could be at risk from new diseases, temperature changes, or other challenges, which can lead to extinction.

**Q57. Give an example of an organism that can reproduce both sexually and asexually.**
**Answer:** Fungi are a good example. Many fungi can reproduce asexually by producing spores, but they can also reproduce sexually when conditions are not suitable. This gives them the advantage of producing many identical offspring when conditions are stable and introducing variation when adaptation is needed. Other examples include strawberry plants and malarial parasites.

**Q58. How do malarial parasites use both sexual and asexual reproduction in their life cycle?**
**Answer:** Malarial parasites reproduce asexually inside the human host, where they multiply quickly and cause illness. However, when a mosquito bites an infected person, the parasites enter the mosquito and reproduce sexually there. This combination allows rapid increase in number inside humans and variation through sexual reproduction in mosquitoes, helping the parasite survive in different conditions.

**Q59. Describe how fungi benefit from using both types of reproduction.**
**Answer:** Fungi use asexual reproduction when conditions are stable to produce many identical spores quickly. This helps spread and grow fast. When conditions become harsh or change, fungi can switch to sexual reproduction, which introduces variation. This variation gives some fungi a better chance to survive and adapt. By using both methods, fungi are more flexible and can survive in many environments.

**Q60. What is the advantage for plants like strawberries to reproduce asexually by runners?**
**Answer:** When strawberry plants reproduce by runners, they produce new plants that are genetically

identical to the parent. This method is fast and does not require pollination or seeds. It allows strawberries to spread and cover the ground quickly when conditions are good. Since the new plants are clones, they keep the good traits of the parent plant, like sweet fruit or strong roots.

**Q61. Why might daffodils reproduce asexually through bulb division?**
**Answer:** Daffodils reproduce through bulb division because it's a fast and reliable way to produce new plants. Each new bulb grows into a plant identical to the parent, which means the good features are kept. This is useful in gardens and farming because it ensures the flowers bloom the same way each year. It also helps daffodils survive cold seasons underground and grow again in spring.

**Q62. Compare the speed and efficiency of sexual and asexual reproduction.**
**Answer:** Asexual reproduction is usually faster and more efficient than sexual reproduction because it only needs one parent and does not involve finding a mate or fertilisation. It allows quick population growth when conditions are stable. Sexual reproduction takes more time and energy, but it produces variation, which helps species survive in changing environments. So, asexual is quicker, sexual gives more variety.

**Q63. What are the disadvantages of sexual reproduction for single organisms living alone?**
**Answer:** For single organisms living alone, sexual reproduction can be difficult or impossible because it requires two parents. They must find a mate, which uses time and energy and may expose them to danger. If no mate is available, reproduction cannot happen, and the species may not survive. This is a major disadvantage compared to asexual reproduction, which only needs one organism.

**Q64. How can sexual reproduction lead to better survival of a species in the long term?**
**Answer:** Sexual reproduction creates genetic variation in the offspring. This variation means some individuals will have traits that help them survive better if the environment changes. Over time, these traits become more common through natural selection. This helps the species adapt to new conditions, diseases, or climates, improving its chances of long-term survival and reducing the risk of extinction.

**Q65. In what way does asexual reproduction limit genetic diversity?**
**Answer:** Asexual reproduction produces offspring that are genetically identical to the parent. This means there is no mixing of genes and no new combinations. If all individuals have the same genes, they may all respond the same way to disease or environmental changes. Without genetic diversity, a population has less chance of adapting or surviving new threats, which can put the species at risk.

**Q66. Explain why variation is important for natural selection.**
**Answer:** Variation means individuals in a population are different. Some of these differences may give certain individuals a better chance to survive and reproduce. Natural selection favours these individuals, and their traits are passed on. Without variation, all individuals are the same, and if the environment changes, the whole population could be affected equally. Variation allows evolution and long-term survival.

**Q67. Why is it useful for scientists to know which organisms reproduce by both methods?**
**Answer:** Knowing which organisms reproduce both sexually and asexually helps scientists understand how they adapt and survive. It allows researchers to study how they switch between the two methods and under

what conditions. This knowledge can be used in farming, medicine, and conservation. For example, it can help control diseases like malaria or improve crop production through cloning and breeding.

**Q68. How can fungi switch between sexual and asexual reproduction depending on conditions?**
**Answer:** Fungi can reproduce asexually when conditions are good by making spores that grow into new fungi. When conditions become difficult, such as lack of food or water, fungi may switch to sexual reproduction. This creates genetic variation, which increases the chances that some offspring will survive the tough conditions. This flexibility helps fungi survive in changing environments.

**Q69. Describe one reason why asexual reproduction can be risky for a species.**
**Answer:** Asexual reproduction can be risky because all offspring are clones and have the same weaknesses. If a disease or environmental change affects one individual, it can affect all others too. With no variation, the species cannot adapt quickly, and the entire population could die. This lack of diversity makes the species more vulnerable to sudden threats or changes.

**Q70. How does reproduction method affect the ability of a species to adapt?**
**Answer:** Species that reproduce sexually can adapt more easily because of the genetic variation created in offspring. This gives some individuals a better chance to survive changes. Asexual reproduction does not create variation, so adaptation is harder. If the environment stays the same, asexual reproduction is fine. But if it changes, sexual reproduction gives the species a better chance to adapt.

**Q71. What are the roles of spores in the reproduction of fungi?**
**Answer:** Spores are the reproductive cells fungi use to spread and grow. They are usually made through asexual reproduction and can be carried by wind or water to new places. When they land in suitable conditions, they grow into new fungi. Some fungi also make spores through sexual reproduction, which helps create variation and allows them to survive difficult conditions better.

**Q72. Describe how the mosquito plays a role in the sexual reproduction of malaria parasites.**
**Answer:** In the life cycle of malaria parasites, mosquitoes are the host where sexual reproduction happens. When a mosquito bites an infected person, it picks up the parasites. Inside the mosquito's body, the parasites reproduce sexually, creating new forms that can infect the next human the mosquito bites. This sexual stage is important for mixing genes and helping the parasites evolve.

**Q73. What is DNA and where is it found in the cell?**
**Answer:** DNA stands for deoxyribonucleic acid. It is the chemical that carries genetic information in all living organisms. DNA is found inside the nucleus of cells, packaged into structures called chromosomes. It contains the instructions for making proteins, which control the body's structure and functions. Each cell (except red blood cells) contains a full copy of the organism's DNA.

**Q74. Describe the shape and structure of a DNA molecule.**
**Answer:** DNA has a shape called a double helix, which looks like a twisted ladder. It is made of two long strands made up of smaller units called nucleotides. Each nucleotide contains a sugar, a phosphate group, and one of four bases: A, T, C, or G. The bases pair up across the two strands: A with T and C with G. This structure helps DNA store information and copy itself accurately.

**Q75. What is a gene and what does it do?**
**Answer:** A gene is a small section of DNA found on a chromosome. Each gene carries the instructions for making a specific protein. The sequence of bases in the gene tells the cell which amino acids to join and in what order. Proteins control the structure and function of the body. So, genes are responsible for inherited characteristics like eye colour or blood type.

**Q76. How does a gene control the production of a specific protein?**
**Answer:** A gene contains a sequence of DNA bases that provides instructions for making a specific protein. The order of the bases in the gene determines the order of amino acids in the protein. First, the gene is copied into a messenger molecule called mRNA. This mRNA travels to the ribosome, where it is read, and amino acids are assembled in the correct order to form the protein.

**Q77. What is meant by the term 'genome'?**
**Answer:** The genome is the complete set of genetic material in an organism. It includes all of the DNA in all the chromosomes found in the nucleus of the cells. In humans, the genome contains all the genes that control how the body develops and functions, as well as sections of DNA that do not code for proteins but still have important roles.

**Q78. Why is the human genome project important in modern medicine?**
**Answer:** The Human Genome Project identified all the genes in human DNA. This helps doctors and scientists understand the causes of genetic diseases, develop better treatments, and even prevent illnesses. It also helps in personalising medicine, as some treatments work better depending on a person's genetic makeup, and allows for more accurate diagnosis of inherited conditions.

**Q79. How can studying the genome help us understand inherited disorders?**
**Answer:** Studying the genome helps scientists find specific genes linked to inherited disorders. By understanding which changes or mutations in the DNA cause disease, researchers can learn how these conditions develop. This helps with earlier diagnosis, better treatments, and even the possibility of preventing these disorders in future generations through genetic counselling or therapies.

**Q80. Give one reason why it is useful to find genes linked to specific diseases.**
**Answer:** Finding genes linked to diseases helps doctors predict who might be at risk. This allows people to take early steps to prevent the disease or monitor it closely. It also helps researchers develop targeted treatments that work better for people with that specific genetic change, improving the chances of successful treatment and reducing side effects.

**Q81. How can knowledge of the genome help trace human migration from the past?**
**Answer:** Scientists compare DNA from different human populations to find similarities and differences. These patterns show how groups of people moved across the world over time. By studying the genome, researchers can trace where people lived, how they spread to new areas, and how they adapted to different environments, giving us a better picture of human history.

**Q82. What role do chromosomes play in storing genetic information?**
**Answer:** Chromosomes are structures found in the nucleus of cells that are made of DNA. They store all the

genetic information needed for an organism to grow, develop, and function. Each chromosome contains many genes, which are the instructions for making proteins. Humans have 23 pairs of chromosomes, and together they hold the entire genome of a person.

**Q83. How is DNA organised within chromosomes?**
**Answer:** DNA is coiled and folded tightly around proteins called histones to fit inside the small space of the cell nucleus. These coiled strands form a compact structure called a chromosome. The DNA on each chromosome is arranged in sections called genes, which each code for specific proteins. This organised structure allows the cell to read the genetic code correctly.

**Q84. Explain how proteins are made using the instructions in DNA.**
**Answer:** First, the DNA code in a gene is copied into messenger RNA (mRNA) in the nucleus. This mRNA moves to the ribosome in the cytoplasm. The ribosome reads the sequence of bases on the mRNA in groups of three, called codons. Each codon codes for a specific amino acid. The ribosome joins the amino acids in the correct order to make the protein.

**Q85. How could knowing someone's genome help doctors choose the best treatment?**
**Answer:** Different people can respond differently to the same medicine because of their genes. By knowing someone's genome, doctors can choose a treatment that is more likely to work for that person and avoid medicines that might cause side effects. This approach, called personalised medicine, helps improve recovery, reduce risk, and make treatment more effective and safer.

**Q86. Why is DNA described as a polymer?**
**Answer:** DNA is called a polymer because it is made from many repeating units called nucleotides, which are joined together in a long chain. Each nucleotide contains a sugar, a phosphate group, and a base. These repeating structures form a large molecule, which is what a polymer is. The long chains of DNA store genetic information and can be very long.

**Q87. Describe how DNA leads to differences between individuals.**
**Answer:** DNA contains the instructions that control everything in the body, including traits like eye colour, height, and health. Although all humans share most of their DNA, small differences in the base sequence of genes create different versions of traits. These differences, or genetic variation, lead to each person having a unique combination of features and characteristics.

**Q88. Why is the order of bases in DNA important?**
**Answer:** The order of bases in DNA determines the order of amino acids in a protein. Proteins are made from chains of amino acids, and even a small change in the base sequence can lead to a different protein being made. If the order is wrong, the protein may not work correctly or may not be made at all, which can lead to problems or diseases.

**Q89. What might happen if there is a change in the DNA sequence of a gene?**
**Answer:** A change in the DNA sequence of a gene is called a mutation. Some mutations have no effect, but others can change the protein that is made. The protein might not work properly or may not be made at all.

This can cause diseases or disorders. In some cases, a mutation might improve the protein and give the organism an advantage in its environment.

**Q90. How can a single gene affect the traits of an organism?**
**Answer:** A single gene contains the instructions to make a specific protein. Proteins control many parts of the body, including how cells function, how the body grows, and how it responds to the environment. If a gene changes, the protein it makes may change too. This can lead to a visible trait being different, such as eye colour or the ability to digest certain foods.

**Q91. How is the study of genomes helping scientists develop new treatments?**
**Answer:** By studying genomes, scientists can identify genes linked to diseases and understand how those diseases work. This helps them create new drugs that target specific genes or proteins. It also allows for the development of gene therapy, where faulty genes are replaced or repaired. Understanding the genome also helps with predicting disease risk and creating personalised treatments.

**Q92. What is the relationship between DNA, genes, and chromosomes?**
**Answer:** DNA is the chemical that carries genetic information. A gene is a small section of DNA that contains the instructions for making a protein. DNA is organised into larger structures called chromosomes, which are found in the cell nucleus. So, genes are made of DNA, and chromosomes are made of many genes and long strands of DNA.

**Q93. What is the advantage of understanding gene locations in the genome?**
**Answer:** Knowing where specific genes are located in the genome helps scientists find out which genes are linked to diseases or traits. This helps with diagnosis, treatment, and understanding how the body works. It also allows doctors to target the right genes with medicine or gene therapy. This knowledge is key to personalised medicine and improving healthcare.

**Q94. How might studying the genome reduce the risk of inherited disease?**
**Answer:** Studying the genome helps scientists find out which genes cause inherited diseases. People can be tested to see if they carry faulty genes. If they do, doctors can give advice on how to reduce the risk, such as lifestyle changes or early treatment. In some cases, gene therapy or other treatments might be used to prevent the disease from developing.

**Q95. How can identifying genes help in preventing certain diseases?**
**Answer:** If scientists know which genes cause a disease, people can be tested to see if they carry them. If they do, doctors can give early advice, start treatment sooner, or monitor the person closely. This helps prevent the disease or catch it early. It also helps in making choices, like avoiding certain medicines or planning for family health.

**Q96. What technology is used to read and map the human genome?**
**Answer:** DNA sequencing technology is used to read the human genome. This technology looks at the order of the DNA bases. Computers then map this information to show where each gene is located. The Human Genome Project used large sequencing machines, but now faster and cheaper methods like next-generation sequencing are available, making it easier to study genomes.

**Q97. Why is the double helix structure important for DNA's function?**
**Answer:** The double helix shape of DNA helps it to store information safely and copy itself accurately. The two strands can separate so that the base sequence can be copied. The base-pairing rules (A with T and C with G) make sure the copy is correct. The twisted structure also makes DNA strong and compact, so it fits inside the nucleus while holding a large amount of information.

**Q98. How is genetic material passed from parents to offspring?**
**Answer:** During reproduction, each parent passes half of their genetic material to the offspring through gametes (sperm and egg cells). These cells contain only half the number of chromosomes. When fertilisation happens, the chromosomes from the two parents combine to form a full set. This is how traits are passed on from parents to children through their genes.

**Q99. How does a mutation in a gene affect the genome?**
**Answer:** A mutation in a gene changes the base sequence of the DNA. This can change the protein that the gene makes, which might affect how the body works. The overall structure of the genome remains the same, but the information in it is different. Some mutations have no effect, some cause disease, and others might give advantages that help in evolution.

**Q100. How can genome research benefit future generations?**
**Answer:** Genome research can lead to better treatments, earlier diagnosis, and even prevention of diseases. It helps scientists understand how the body works and what causes health problems. This knowledge can be passed on to future generations, improving healthcare. It also helps in developing new medicines, personalised treatments, and understanding how humans evolved and adapted.

**Q101. What are the three parts that make up a DNA nucleotide?**
**Answer:** A DNA nucleotide is made up of three parts: a sugar called deoxyribose, a phosphate group, and a nitrogenous base. These parts join together to form the building blocks of DNA. The sugar and phosphate make the backbone of the DNA strand, while the base sticks out and pairs with another base on the opposite strand to hold the two strands together.

**Q102. Describe the role of the sugar and phosphate groups in the DNA strand.**
**Answer:** The sugar and phosphate groups form the backbone of the DNA molecule. They link together in a repeating pattern to create a strong chain. The sugar of one nucleotide connects to the phosphate of the next, forming a long, stable strand. This structure holds the nitrogen bases in place, allowing them to pair correctly and protect the genetic information.

**Q103. Name the four bases found in DNA.**
**Answer:** The four bases found in DNA are adenine (A), thymine (T), cytosine (C), and guanine (G). These bases form specific pairs: adenine pairs with thymine, and cytosine pairs with guanine. The order of these bases along the DNA strand is what determines the genetic code used to make proteins.

**Q104. What is the relationship between the sequence of bases in DNA and amino acids?**
**Answer:** The sequence of bases in DNA determines the order of amino acids in a protein. Each group of three bases (called a codon) codes for one specific amino acid. The sequence of codons in a gene tells the

cell which amino acids to link together and in what order, creating a protein with a particular structure and function.

**Q105. How does a sequence of three bases code for one amino acid?**
**Answer:** In DNA, every three bases form a triplet code, known as a codon, that corresponds to one specific amino acid. When the gene is read during protein synthesis, each codon is matched with the correct amino acid. These amino acids are then joined together to form a protein, with the sequence of triplets determining the exact structure of the protein.

**Q106. What is meant by the term "DNA is a polymer"?**
**Answer:** DNA is called a polymer because it is made up of many repeating units called nucleotides. These nucleotides are joined together in long chains to form a very large molecule. Polymers are substances made from repeating parts, and in DNA, the repeating parts are the sugar, phosphate, and base units that form each nucleotide.

**Q107. Describe how DNA strands are formed using nucleotides.**
**Answer:** DNA strands are formed when nucleotides join together. The phosphate group of one nucleotide links to the sugar of the next, creating a strong sugar-phosphate backbone. The nitrogenous bases stick out from this backbone and pair with complementary bases on the other strand (A with T, C with G), forming a double helix. This structure keeps the DNA stable and compact.

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**Answer:** In DNA, the bases pair in a specific way. Adenine (A) always pairs with thymine (T), and cytosine (C) always pairs with guanine (G). These pairs are held together by hydrogen bonds. This base pairing rule ensures that the DNA can be copied accurately during cell division and that the genetic information stays the same.

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**Answer:** In DNA, adenine (A) always pairs with thymine (T). This pairing is due to the specific shapes and bonding patterns of the bases, which fit together like puzzle pieces. The pairing helps maintain the structure of the DNA double helix and allows for accurate copying of the genetic code.

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**Answer:** At the ribosome, the mRNA copy of the gene is read three bases at a time. Each group of three bases (codon) matches a specific amino acid. Carrier molecules called tRNA bring the correct amino acids to the ribosome. The ribosome joins the amino acids together in the right order, forming a chain that folds into a functional protein.

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**Answer:** After a protein chain is completed, it folds into a specific shape. This folding happens because of interactions between the amino acids, such as attractions, repulsions, and bonding. The final shape of the protein is essential for its function. If it does not fold properly, the protein may not work or may cause problems in the body.

**Q116. What does the shape of a protein allow it to do in the body?**
**Answer:** The shape of a protein allows it to do its job. For example, enzymes have a shape that fits with a specific molecule, like a key in a lock. Structural proteins like collagen are shaped to provide strength. If the shape changes, the protein might not work properly. That's why the shape, which depends on the amino acid order, is very important.

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**Q119. What is the effect of a mutation in a coding region of DNA?**
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**Answer:** Non-coding DNA doesn't make proteins, but it can control how and when genes are used. A change in non-coding DNA can affect whether a gene is switched on or off, or how much protein is made. If this regulation is disrupted, it can lead to the gene making too much or too little protein, which might cause health problems or affect development.

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**Q126. Describe how non-coding DNA controls gene expression.**

**Answer:**

Non-coding DNA does not make proteins, but it plays an important role in controlling gene expression. It contains regions that act as switches to turn genes on or off. These regions help decide when a gene should be active, how much protein it should make, and in which cells the gene should be used. Proteins called transcription factors bind to these non-coding regions and control whether a gene gets copied into mRNA or not.

**Q127. How can a mutation in non-coding DNA affect the phenotype of an organism?**

**Answer:**

A mutation in non-coding DNA can change how genes are turned on or off. This can lead to too much, too little, or the wrong timing of protein production. If a gene that affects appearance or body function is not expressed properly, the organism's phenotype may change. For example, if a gene for skin pigment is not activated at the right time, the organism might have lighter or darker skin than normal.

**Q128. What is meant by the term “phenotype”?**

**Answer:**

Phenotype means the visible or measurable features of an organism, such as hair colour, height, or eye shape. It is the result of the interaction between an organism’s genes and the environment. For example, a plant’s height may depend on its genes and how much water or sunlight it gets. So, phenotype includes both inherited traits and the influence of the surroundings.

**Q129. Why do most mutations have little or no effect on phenotype?**

**Answer:**

Most mutations do not affect the phenotype because they either happen in non-coding parts of DNA or do not change the amino acid made due to the genetic code being degenerate (some codons code for the same amino acid). Also, the body has repair systems to fix DNA, and many proteins can still work if only one amino acid is changed slightly. So, most changes do not affect how the organism looks or functions.

**Q130. How often do mutations occur in DNA?**

**Answer:**

Mutations occur all the time in DNA, but the rate is usually very low. Every time a cell divides, small mistakes can happen during the copying of DNA. On average, mutations may occur once in every few million bases

copied. However, most of these are corrected by the cell's repair systems, and only a small number of mutations stay in the DNA.

**Q131. Why do some mutations lead to changes in the protein made while others do not?**

**Answer:**

Some mutations change a base in the DNA that does not affect the amino acid made because the genetic code has several codons for the same amino acid. These are called silent mutations. Other mutations might change one amino acid but not affect the protein's function. But some mutations change the shape of the protein so much that it no longer works. So, the effect depends on where and how the mutation occurs.

**Q132. What is the function of a ribosome in a cell?**

**Answer:**

The ribosome is the part of the cell where proteins are made. It reads the genetic instructions from mRNA and joins amino acids together in the correct order to make a protein. Ribosomes act like tiny factories that follow the mRNA code and build proteins by linking amino acids using peptide bonds. This process is called translation.

**Q133. Describe how the correct amino acids are brought to the ribosome during protein synthesis.**

**Answer:**

During protein synthesis, tRNA molecules bring the correct amino acids to the ribosome. Each tRNA has an anticodon that matches a codon on the mRNA. The ribosome reads the mRNA one codon at a time, and the matching tRNA with the correct amino acid attaches. The ribosome then joins the amino acids together to form a protein in the correct order.

**Q134. Why is it important for the amino acids to be added in the correct order?**

**Answer:**

The order of amino acids decides how a protein folds and what shape it takes. This shape is very important because it allows the protein to do its job properly. If the amino acids are in the wrong order, the protein might not fold correctly, and it may not work or may do the wrong thing. This can cause cells to malfunction and lead to diseases.

**Q135. What happens if one base in a gene is deleted?**

**Answer:**

If one base is deleted from a gene, it can cause a frameshift mutation. This changes the way the rest of the genetic code is read because every codon (group of 3 bases) shifts. As a result, different amino acids are added, and the protein will likely be non-functional. This can cause serious problems in the cell or organism.

**Q136. What happens if an extra base is inserted into a gene sequence?**

**Answer:**

Inserting an extra base into a gene also causes a frameshift mutation. This shifts the reading frame of the codons, changing all the amino acids after the point of insertion. The protein made will likely have the wrong shape and may not work at all. This can lead to harmful effects or genetic disorders.

**Q137. What is the difference between an insertion and a deletion mutation?**

**Answer:**

An insertion mutation happens when an extra base is added into the DNA sequence. A deletion mutation is when a base is removed. Both types of mutations can change the reading frame of the gene (called a frameshift), which affects how the rest of the gene is read and what protein is made. Both can have serious effects if they happen in important parts of the gene.

**Q138. How can insertion or deletion mutations affect the protein made?**

**Answer:**

Insertion or deletion mutations can cause a frameshift, which changes the groupings of bases into codons. This means that the ribosome reads the wrong amino acids from that point onward. The protein produced will have a different shape and may not work. This can lead to diseases or other serious problems in the organism.

**Q139. Give an example of how a mutation can be harmful.**

**Answer:**

A harmful mutation can happen in the gene that makes haemoglobin, the protein in red blood cells. In sickle cell disease, a mutation causes haemoglobin to form wrongly, making red blood cells shaped like sickles. These cells block blood flow and break easily, causing pain, infections, and other serious health problems.

**Q140. Give an example of a mutation that may be beneficial.**

**Answer:**

Sometimes, a mutation can help an organism survive better. For example, a mutation in some people makes them resistant to HIV. This mutation affects a protein called CCR5, which the virus uses to enter cells. People with this mutation are less likely to get infected. So, in some situations, mutations can provide advantages.

**Q141. Why is it important that the structure of DNA is stable but also allows copying?**

**Answer:**

DNA must be stable so it can safely store genetic information for many years. Its double-helix shape and strong sugar-phosphate backbone make it secure. But it also needs to be easy to copy when cells divide. The hydrogen bonds between bases are weak enough to break during replication, so the strands can be separated and copied. This balance allows life to continue.

**Q142. What role do hydrogen bonds play in the DNA structure?**

**Answer:**

Hydrogen bonds hold the two strands of the DNA double helix together. They form between matching base pairs: A with T (2 bonds) and C with G (3 bonds). These bonds are weak enough to be broken during DNA replication but strong enough to keep the strands together and maintain the DNA's stable structure.

**Q143. What might happen if a mutation occurs in a gene that codes for an enzyme?**

**Answer:**

If a mutation changes the shape of the enzyme's active site, the enzyme may no longer bind to its substrate, meaning the reaction it helps with will not happen. This can lead to problems in the cell, like toxic substances

building up or needed substances not being made. Inherited diseases like phenylketonuria can be caused by enzyme mutations.

**Q144. How does the shape of a protein relate to its ability to bind to other molecules?**
**Answer:**
A protein's shape is very important for binding. It must have the correct 3D shape to fit the molecule it needs to attach to, like a key fitting into a lock. If the shape is wrong, the protein won't bind properly and won't work. This is true for enzymes, antibodies, hormones, and many other proteins.

**Q145. Explain how DNA controls the function of a cell.**
**Answer:**
DNA controls a cell by carrying the instructions to make proteins. Proteins do most of the work in cells, like building structures, carrying messages, and speeding up reactions. By choosing which genes are turned on or off, DNA decides which proteins are made and when. This controls the cell's function and activity.

**Q146. How could a mutation in DNA lead to disease?**
**Answer:**
A mutation in DNA can change the instructions for making a protein. If the protein is not made correctly, it may not work or could cause problems in the cell. For example, in cystic fibrosis, a mutation changes a protein that controls salt and water in cells. This causes thick mucus to build up, leading to lung and digestive problems.

**Q147. Why is protein shape important for hormone function?**
**Answer:**
Hormones must fit into specific receptors on cells to send their messages. If the protein hormone's shape is wrong, it won't bind to its receptor, and the message won't be received. This can affect growth, metabolism, or mood. So, the shape is essential for the hormone to do its job properly.

**Q148. Why is protein synthesis described as a highly controlled process?**
**Answer:**
Protein synthesis is controlled so that only the needed proteins are made at the right time and in the right amount. This is important because making the wrong protein or too much of it can harm the cell. The process includes checking the mRNA, matching the right tRNA, and folding the protein correctly. Mistakes are rare because the cell has many ways to control and fix errors.

**Q149. What role do genes play in determining the characteristics of an organism?**
**Answer:**
Genes carry the instructions for making proteins, which affect how the organism looks and works. For example, genes control eye colour, blood type, and how the body fights disease. Different versions of a gene (alleles) can lead to different traits. So, genes play a big role in shaping an organism's characteristics or phenotype.

**Q150. How could modelling mutations help students understand their effects on DNA and proteins?**
**Answer:**

Modelling mutations lets students see how DNA changes affect protein structure. By using beads, colours, or computer models, they can watch how a base change can alter a codon, which then changes the amino acid and possibly the whole protein. This makes the concept easier to understand and shows clearly how small changes can have big effects on the body.

**Q151. What is a gamete and what role does it play in inheritance?**

**Answer:** A gamete is a sex cell that carries half the genetic information of an organism. In humans, sperm is the male gamete and the egg is the female gamete. During fertilisation, a sperm and egg join to form a zygote with a full set of chromosomes. Gametes are important in inheritance because they pass on genes from parents to offspring. Each gamete contributes one allele for every gene, which helps determine the traits of the new organism.

**Q152. Define the term chromosome and describe its function.**

**Answer:** A chromosome is a long, coiled structure made of DNA found in the nucleus of cells. Humans have 46 chromosomes in total, arranged in 23 pairs. Each chromosome contains many genes. The main function of chromosomes is to carry genetic information that controls how an organism develops and functions. During reproduction and cell division, chromosomes ensure that DNA is passed correctly to new cells or offspring.

**Q153. What is a gene and what does it control in an organism?**

**Answer:** A gene is a small section of DNA that contains the instructions for making a specific protein. These proteins carry out different jobs in the body, such as building cells or controlling chemical reactions. Genes control the development of traits or characteristics in an organism, such as eye colour, blood type, or height. Each gene is found at a fixed location on a chromosome and can exist in different forms called alleles.

**Q154. What is meant by an allele in genetics?**

**Answer:** An allele is a different version of a gene. For each gene, an organism usually has two alleles—one inherited from each parent. Some alleles may be dominant, and others may be recessive. These different alleles affect the way a trait is expressed in the organism. For example, the gene for eye colour has alleles for blue, brown, and green eyes. Which alleles a person inherits will help decide their eye colour.

**Q155. Explain the difference between dominant and recessive alleles.**

**Answer:** A dominant allele is always expressed in the phenotype, even if only one copy is present. A recessive allele is only expressed if an organism has two copies of it. If a person has one dominant and one recessive allele for a trait, the dominant one will show in the phenotype. For example, the allele for brown eyes is dominant, so it shows even if the other allele is for blue eyes, which is recessive.

**Q156. What does homozygous mean in terms of alleles?**

**Answer:** Homozygous means that both alleles for a particular gene are the same. This can be either two dominant alleles (homozygous dominant) or two recessive alleles (homozygous recessive). For example, a person with two alleles for brown eyes (BB) is homozygous dominant, and someone with two alleles for blue eyes (bb) is homozygous recessive. Being homozygous affects how traits are expressed.

**Q157. What does heterozygous mean in terms of alleles?**

**Answer:** Heterozygous means that the two alleles for a gene are different—one dominant and one

recessive. For example, if a person has one allele for brown eyes and one for blue eyes (Bb), they are heterozygous. In most cases, the dominant allele will be expressed in the phenotype, so this person would have brown eyes. The recessive allele can still be passed on to offspring.

**Q158. Define the term genotype and give an example.**
**Answer:** A genotype is the combination of alleles that an organism has for a particular gene. It shows the genetic makeup, not the visible trait. For example, a person with one brown eye allele and one blue eye allele has the genotype Bb. Genotypes can be homozygous dominant (BB), homozygous recessive (bb), or heterozygous (Bb), and they help determine what traits are shown in the phenotype.

**Q159. Define the term phenotype and explain what influences it.**
**Answer:** A phenotype is the physical appearance or trait that an organism shows, such as eye colour, height, or blood group. It is influenced by the organism's genotype (the alleles it carries) and sometimes by the environment. For example, a plant's height might be controlled by its genes, but it may also be affected by sunlight or water. So phenotype results from both genes and environmental factors.

**Q160. How does a dominant allele affect the phenotype of an organism?**
**Answer:** A dominant allele affects the phenotype by being expressed even if only one copy is present. This means that if a person has one dominant and one recessive allele, the dominant one will show in their traits. For example, if brown eyes are controlled by a dominant allele, a person only needs one brown eye allele to have brown eyes, even if the other allele is for blue eyes.

**Q161. Why is a recessive allele not always expressed in the phenotype?**
**Answer:** A recessive allele is not always expressed because it is hidden when a dominant allele is also present. For a recessive trait to show in the phenotype, the organism must inherit two copies of the recessive allele—one from each parent. If only one recessive allele is present, the dominant allele will take control, and the trait will not be visible, although the organism can still pass it on.

**Q162. Describe an example of a characteristic controlled by a single gene.**
**Answer:** One example is dimples. Whether a person has dimples or not is often controlled by a single gene. The allele for dimples is dominant, so a person only needs one copy of this allele to have dimples. If they have two recessive alleles, they will not have dimples. This shows how a single gene can control a specific characteristic in a simple pattern.

**Q163. How do alleles influence the development of a characteristic?**
**Answer:** Alleles decide what version of a characteristic an organism will show. Since each gene has two alleles, one from each parent, the combination of these alleles affects how a trait is expressed. If both alleles are the same, the trait is clearly shown. If the alleles are different, the dominant one usually decides the outcome. For example, in flower colour, different allele combinations can produce red, pink, or white flowers.

**Q164. Explain why most characteristics are controlled by more than one gene.**
**Answer:** Most characteristics, like height, skin colour, and intelligence, are controlled by many genes working together. These are called polygenic traits. Each gene adds a small amount to the overall effect, leading to a

wide range of variation. This is why such traits don't follow simple dominant and recessive patterns and show a mix of features rather than just one or the other.

**Q165. How can you use a Punnett square to predict the outcome of a genetic cross?**
**Answer:** A Punnett square helps predict the chances of offspring inheriting certain traits by showing all possible combinations of alleles from two parents. You write one parent's alleles along the top and the other's down the side, then fill in the boxes to see the possible genotypes of the offspring. It shows the ratio of dominant to recessive traits that could appear in the children.

**Q166. Why is probability used in predicting genetic outcomes?**
**Answer:** Probability is used because inheritance is a random process. When gametes combine, the combination of alleles is not guaranteed, so we use probability to estimate the chances of certain traits appearing. For example, if there is a 1 in 4 chance of a child inheriting two recessive alleles, probability helps us understand the likely outcomes, though it cannot predict the exact result for one child.

**Q167. What is the expected ratio of offspring when two heterozygous parents are crossed?**
**Answer:** When two heterozygous parents (for example, Bb x Bb) are crossed, the expected ratio of offspring is 1 BB : 2 Bb : 1 bb. This means 25% will be homozygous dominant, 50% heterozygous, and 25% homozygous recessive. In terms of phenotype, if B is dominant, about 75% of the offspring will show the dominant trait and 25% the recessive one.

**Q168. What would be the phenotype ratio of offspring from two homozygous parents, one dominant and one recessive?**
**Answer:** If one parent is homozygous dominant (BB) and the other is homozygous recessive (bb), all their offspring will be heterozygous (Bb). Since the dominant allele is present, 100% of the offspring will show the dominant trait in their phenotype. So, the phenotype ratio will be 100% dominant and 0% recessive.

**Q169. How can direct proportion help in understanding genetic crosses?**
**Answer:** Direct proportion helps by showing how the number of offspring with a certain trait relates to the total number of offspring. For example, if 3 out of 4 offspring show a dominant trait, we can say the proportion is 3:4 or 75%. This helps in understanding and predicting how often a trait will appear in a large group, based on the genetic cross.

**Q170. How is a Punnett square useful in genetic prediction?**
**Answer:** A Punnett square is useful because it clearly shows all the possible allele combinations in the offspring of two parents. It helps predict the genotypes and phenotypes that might result from a genetic cross. It also helps explain inheritance patterns like dominant and recessive traits, and is a simple way to calculate genetic probabilities.

**Q171. What is polydactyly and how is it inherited?**
**Answer:** Polydactyly is a condition where a person is born with extra fingers or toes. It is caused by a dominant allele, so only one copy of the allele is needed for the trait to appear. If one parent has polydactyly and passes on the allele, the child can inherit the condition even if the other parent doesn't have it.

**Q172. Why can polydactyly be passed on by just one parent?**
**Answer:** Polydactyly can be passed on by just one parent because it is caused by a dominant allele. A person only needs one copy of the faulty allele to show the condition. So, if one parent has the dominant allele, there is a 50% chance they will pass it to their child, even if the other parent does not have the condition.

**Q173. What is cystic fibrosis and how is it inherited?**
**Answer:** Cystic fibrosis is a genetic disorder that affects the lungs and digestive system by causing thick, sticky mucus to build up. It is inherited in a recessive pattern, meaning a person needs two copies of the faulty allele (one from each parent) to have the disease. If they only inherit one copy, they will be a carrier but will not show symptoms.

**Q174. Why must both parents carry the allele for a child to inherit cystic fibrosis?**
**Answer:** Both parents must carry the allele because cystic fibrosis is caused by a recessive allele. For a child to have the disease, they must inherit two copies—one from each parent. If only one parent carries the allele, the child might inherit it and become a carrier but will not develop cystic fibrosis. Only when both parents are carriers is there a chance the child will get both recessive alleles.

**Q175. How can a person be a carrier of a genetic disorder?**
**Answer:** A person is a carrier if they have one faulty allele for a genetic disorder and one normal allele. This means they do not show symptoms of the disorder but can pass the faulty allele to their children. Carriers are common in recessive conditions like cystic fibrosis. If two carriers have a child, there is a chance the child could inherit both faulty alleles and have the disorder.

**Q176. What does it mean if a person is heterozygous for a recessive disorder?**
**Answer:** A person who is heterozygous for a recessive disorder has one normal allele and one faulty allele for the disorder. They are known as a carrier. They do not show symptoms of the disorder because the normal allele is dominant and covers up the effect of the faulty one. However, they can pass the faulty allele on to their children. If both parents are carriers, there is a chance their child could inherit both faulty alleles and have the disorder.

**Q177. Explain how embryo screening can be used to detect genetic disorders.**
**Answer:** Embryo screening is a process where cells from an embryo created during IVF are tested for genetic disorders before the embryo is implanted into the womb. Scientists look for faulty alleles linked to specific inherited conditions. If the embryo has a disorder, it may not be used. This helps parents choose embryos that are less likely to develop serious genetic conditions, reducing the risk of passing on inherited diseases.

**Q178. What is one ethical concern about embryo screening?**
**Answer:** One ethical concern about embryo screening is that it may lead to choosing embryos based on preferred traits, not just for health reasons. Some people worry this could lead to "designer babies," where people might want to pick eye colour or intelligence. Others believe it could lead to discrimination against people living with disabilities, suggesting their lives are less valuable.

**Q179. How can embryo screening reduce suffering from genetic disorders?**
**Answer:** Embryo screening helps reduce suffering by identifying embryos that do not carry serious genetic conditions. This allows parents to choose embryos with a lower risk of disease, which can prevent children from being born with painful or life-threatening conditions. This means fewer people may suffer from illnesses like cystic fibrosis or Tay-Sachs disease, and families may avoid the emotional and financial stress of caring for a sick child.

**Q180. Give one economic concern related to widespread embryo screening.**
**Answer:** One economic concern is the high cost of embryo screening. It requires advanced technology and trained staff, making it expensive. If used widely, it could increase pressure on healthcare systems, especially in countries with limited resources. Some people also worry that only wealthy families may afford it, which could increase inequality in access to genetic health benefits.

**Q181. How might embryo screening affect decisions made by parents?**
**Answer:** Embryo screening can make decisions difficult for parents, especially if they find out their embryo has a serious disorder. They may face emotional stress and feel pressured to choose certain embryos. Some may also struggle with religious or moral beliefs about selecting embryos. It can be helpful in preventing disease, but it also brings tough choices about which embryos to keep or discard.

**Q182. What social issues might arise from selecting embryos based on genetics?**
**Answer:** Selecting embryos based on genetics can lead to social problems like discrimination against people with disabilities. It might make people feel that only certain traits are “acceptable.” There’s also a risk that some traits could be seen as more valuable than others, which could increase inequality or bullying. Society might begin to judge people based on their genes rather than their character or actions.

**Q183. Why do some people support the use of embryo screening?**
**Answer:** Some people support embryo screening because it can prevent children from being born with serious genetic conditions. This reduces pain, suffering, and medical costs. It gives parents more control and helps ensure a healthier life for their children. Supporters believe it is a responsible choice if it helps avoid future illness and improves the quality of life for families.

**Q184. Why do some people oppose the use of embryo screening?**
**Answer:** Some people oppose embryo screening for ethical and religious reasons. They believe it interferes with natural life or that all embryos have a right to life, even those with disorders. Others worry it may be misused to select traits like appearance or intelligence, leading to discrimination or "designer babies." They also worry it sends the message that people with disabilities are less valuable.

**Q185. What are the potential benefits of gene therapy for genetic disorders?**
**Answer:** Gene therapy has the potential to fix the cause of a genetic disorder by correcting or replacing the faulty gene. This could lead to permanent cures for conditions like cystic fibrosis or muscular dystrophy. It may reduce the need for long-term treatment and improve the quality of life for patients. Gene therapy offers hope for diseases that currently have no cure.

**Q186. What are the risks involved in using gene therapy?**
**Answer:** Gene therapy can be risky because it involves changing a person's DNA. Sometimes the new gene might not work properly, or it could affect the wrong part of the DNA, causing other health problems like cancer. There's also a risk of side effects or rejection by the body. Because gene therapy is still being developed, scientists are still studying how to make it safer and more reliable.

**Q187. What is meant by sex determination?**
**Answer:** Sex determination is the process by which an organism develops as male or female. In humans, this is decided by the combination of sex chromosomes inherited from the parents. A fertilised egg that receives an X chromosome from the mother and a Y chromosome from the father develops into a male (XY), while one that receives two X chromosomes (XX) develops into a female.

**Q188. How many pairs of chromosomes are in a human body cell?**
**Answer:** A human body cell has 23 pairs of chromosomes, making a total of 46 chromosomes. One pair determines the person's sex, and the other 22 pairs are called autosomes. Each parent contributes one chromosome to each pair, so children inherit half of their chromosomes from their mother and half from their father.

**Q189. Which pair of chromosomes determine the sex of a person?**
**Answer:** The 23rd pair of chromosomes determines the sex of a person. These are known as the sex chromosomes. Females have two X chromosomes (XX), and males have one X and one Y chromosome (XY). The combination of these chromosomes decides whether the baby will be male or female.

**Q190. What sex chromosomes are found in females?**
**Answer:** Females have two X chromosomes in their cells. This is written as XX. Since females only have X chromosomes, they can only pass on an X chromosome to their children. The child's sex then depends on whether the father contributes an X or Y chromosome during fertilisation.

**Q191. What sex chromosomes are found in males?**
**Answer:** Males have one X chromosome and one Y chromosome. This is written as XY. Males can pass either an X or a Y chromosome to their children. If the sperm with the X chromosome fertilises the egg, the child will be female. If the sperm with the Y chromosome fertilises the egg, the child will be male.

**Q192. How can a genetic cross be used to predict the sex of offspring?**
**Answer:** A genetic cross can show the possible combinations of sex chromosomes from the parents. The mother always passes on an X chromosome, while the father can pass on either an X or a Y. A Punnett square can be used to show there is a 50% chance of the child being XX (female) and a 50% chance of being XY (male).

**Q193. What is the probability of a couple having a male child?**
**Answer:** The probability of a couple having a male child is 50%. This is because the mother always provides an X chromosome, and the father has a 50% chance of passing on a Y chromosome. If the sperm that fertilises the egg carries a Y chromosome, the child will be male (XY).

**Q194. What is the probability of a couple having a female child?**
**Answer:** The probability of a couple having a female child is 50%. The mother provides an X chromosome, and if the father's sperm also provides an X, the child will be female (XX). Since the father can give either an X or Y chromosome with equal chance, there is a 1 in 2 chance of having a girl.

**Q195. Draw a simple genetic cross to show how sex is inherited.**
**Answer:** A simple genetic cross would show the mother as XX and the father as XY. The Punnett square would look like this:
Mother's gametes: X, X
Father's gametes: X, Y
Possible combinations: XX (female), XY (male)
Result: 50% chance of female, 50% chance of male offspring.

**Q196. Why do males determine the sex of the child?**
**Answer:** Males determine the sex of the child because they produce two types of sperm—one carrying an X chromosome and one carrying a Y. The mother only provides X chromosomes. If a sperm with an X chromosome fertilises the egg, the child will be female. If a sperm with a Y chromosome fertilises the egg, the child will be male. So, the sex depends on which sperm reaches the egg first.

**Q197. What happens to the sex ratio in a large number of births?**
**Answer:** In a large number of births, the sex ratio usually evens out to about 50% male and 50% female. Although individual families might have more boys or more girls by chance, over a large population the numbers balance. This is because the chance of having a boy or girl is about equal in each pregnancy.

**Q198. How can ratios help to understand the outcome of genetic crosses?**
**Answer:** Ratios help show how likely each outcome is in a genetic cross. For example, a 3:1 ratio means that in every 4 offspring, 3 are likely to show the dominant trait and 1 the recessive trait. Ratios are useful for predicting what traits might appear in a large number of offspring, even if the exact outcome in small groups is uncertain.

**Q199. What is the chance of two heterozygous parents having a child with a recessive disorder?**
**Answer:** If both parents are heterozygous (carriers), each has one normal and one faulty allele. When they have a child, there is a 25% chance the child will inherit both faulty alleles and have the disorder, a 50% chance the child will be a carrier, and a 25% chance the child will inherit two normal alleles. So, the chance of having a child with the disorder is 1 in 4 or 25%.

**Q200. Why are Punnett squares helpful when studying inherited conditions?**
**Answer:** Punnett squares are helpful because they make it easier to see all the possible combinations of alleles from two parents. They show the probabilities of different genotypes and phenotypes in the offspring. This helps in understanding how likely it is for a child to inherit a condition, whether dominant or recessive, and helps explain inheritance clearly in a simple grid format.

**Q201. What is variation and what are its main causes?**
**Answer:** Variation is the differences in traits or characteristics between individuals in a population. The main

causes of variation are genetic and environmental factors. Genetic variation comes from differences in the DNA passed from parents, such as different alleles. Environmental variation is caused by factors like diet, climate, or lifestyle. Mutations can also introduce new genetic variation into a population.

**Q202. How can inherited genes influence the phenotype of an organism?**
**Answer:** Inherited genes affect phenotype because they control the production of proteins, which are responsible for the traits seen in an organism. Different versions of genes, called alleles, can lead to different traits such as eye colour, height, or blood type. The combination of alleles inherited from both parents determines which characteristics are shown in the organism's phenotype.

**Q203. In what way can the environment affect the development of an organism's phenotype?**
**Answer:** The environment can change how a trait develops or how strongly it is expressed. For example, a plant might have genes for growing tall, but if it doesn't get enough water or sunlight, it may stay short. Similarly, a person's diet or exercise can affect body size, even if their genes suggest a different potential. This shows that phenotype is not just controlled by genes, but also by external conditions.

**Q204. Why do identical twins sometimes look slightly different even though they have the same genes?**
**Answer:** Identical twins have the same genetic information because they come from the same fertilised egg. However, they may look slightly different due to environmental influences. Differences in diet, physical activity, illnesses, or even which parts of their genes are turned on or off can cause slight variations in appearance or behaviour, even though their DNA is the same.

**Q205. How do both genetic and environmental factors work together to shape phenotype?**
**Answer:** The phenotype of an organism is shaped by the interaction between its genes and its environment. Genes provide the instructions for traits, but the environment can affect how those instructions are used. For example, a person might have genes for tall height, but if they don't get enough nutrition, they might not reach their full potential. So, both genes and environment combine to influence the final traits.

**Q206. What does it mean when we say there is extensive genetic variation in a population?**
**Answer:** Extensive genetic variation means that there are many different versions of genes in a population. This leads to a wide range of traits among individuals, such as differences in height, hair colour, or resistance to disease. This variety is important because it gives the population a better chance of surviving changes in the environment, since some individuals may have traits that help them adapt.

**Q207. Why is genetic variation important for the survival of a species?**
**Answer:** Genetic variation is important because it allows a species to adapt to changing environments. If all individuals were the same, a single disease or change in climate could wipe them all out. But with variation, some individuals may have traits that help them survive and reproduce. These traits are then passed on, helping the species continue and possibly evolve over time.

**Q208. How do mutations contribute to genetic variation?**
**Answer:** Mutations are changes in the DNA of a gene. They can introduce new alleles into a population, which adds to genetic variation. Some mutations may have no effect, while others can produce new traits. If a

mutation gives an advantage, it might become more common through natural selection. Over time, mutations play an important role in evolution by creating new genetic material for selection to act on.

**Q209. Why do most mutations have no effect on the phenotype?**
**Answer:** Most mutations have no effect on the phenotype because they occur in parts of the DNA that don't affect important genes, or they don't change the protein that is made. Sometimes, even if a protein is slightly changed, it still works normally. This is why many mutations are called "silent" mutations—they happen, but they don't make a noticeable difference to how the organism looks or works.

**Q210. Give an example of a mutation that might affect an organism's phenotype.**
**Answer:** A mutation in the gene that controls skin colour might change the amount of pigment the skin produces, resulting in a different skin tone. Another example is a mutation in the gene for haemoglobin, which can lead to sickle cell disease. This condition affects the shape of red blood cells and can cause health problems, clearly showing a change in phenotype due to a mutation.

**Q211. Why do only a few mutations result in new phenotypes?**
**Answer:** Only a few mutations result in new phenotypes because most mutations either have no effect or are corrected by the body. Some mutations may occur in parts of the DNA that don't affect any important functions. Only when a mutation changes a protein in a way that affects the body's structure or function will a new phenotype be seen. These cases are rare but important for evolution.

**Q212. What is the role of mutation in evolution?**
**Answer:** Mutation is the original source of new genetic variation. It creates new alleles, which may result in new traits. If a mutation gives an organism an advantage in survival or reproduction, natural selection may cause it to spread in the population. Over time, many such changes can lead to evolution, where the species becomes better suited to its environment or even develops into a new species.

**Q213. How can a new phenotype from a mutation help a species survive environmental change?**
**Answer:** A new phenotype caused by mutation may help an organism survive better in a changed environment. For example, if the climate becomes colder, a mutation that causes thicker fur could help animals stay warm. These animals may survive longer and have more offspring. Over time, more individuals in the species may have this helpful trait, improving the species' chance of survival.

**Q214. Define evolution in terms of inherited characteristics.**
**Answer:** Evolution is the gradual change in the inherited characteristics of a population over time. These changes happen because of genetic variation, mutations, and natural selection. As certain traits become more common due to survival advantages, the population slowly changes. If these changes continue over many generations, they can lead to the development of a new species.

**Q215. What is natural selection and how does it lead to evolution?**
**Answer:** Natural selection is the process where individuals with traits that help them survive and reproduce are more likely to pass on their genes to the next generation. Over time, helpful traits become more common, while less useful traits may disappear. This causes gradual changes in the population's characteristics, leading to evolution. Natural selection is one of the main ways evolution happens.

**Q216. Describe how natural selection favours organisms with beneficial traits.**
**Answer:** Natural selection favours organisms with traits that help them survive in their environment. These individuals are more likely to live longer and have more offspring. Their helpful traits, controlled by genes, are passed on to the next generation. Over time, these traits become more common in the population, improving the group's ability to survive and reproduce in that environment.

**Q217. Why is it important that variations exist within a species for natural selection to occur?**
**Answer:** Variation is important because it gives natural selection something to act on. If all individuals were the same, none would have an advantage. But when there is variation, some traits may help certain individuals survive better. These individuals are more likely to pass on their traits. Without variation, a species cannot adapt or evolve, and it may not survive changes in the environment.

**Q218. What is meant by the term "survival of the fittest"?**
**Answer:** "Survival of the fittest" means that the organisms best adapted to their environment are more likely to survive and reproduce. "Fittest" does not mean the strongest, but those whose traits are best suited to the current conditions. These individuals pass on their genes, and their traits become more common in the population, leading to evolution over time.

**Q219. What happens to individuals with traits less suited to the environment over time?**
**Answer:** Individuals with traits less suited to the environment are less likely to survive and reproduce. They may struggle to find food, escape predators, or deal with disease. Over time, their traits become less common in the population. If they cannot survive or reproduce successfully, their genetic material may disappear from the gene pool, and their line may die out.

**Q220. How can evolution result in the formation of a new species?**
**Answer:** Evolution can lead to the formation of a new species when two populations of the same species become separated and adapt to different environments. Over many generations, natural selection causes changes in their genes. If the changes become so great that the two populations can no longer interbreed and produce fertile offspring, they are considered different species.

**Q221. What must happen for two populations to become different species?**
**Answer:** For two populations to become different species, they must be separated for a long time and experience different conditions that cause them to evolve differently. Over time, their genes and traits change so much that they can no longer mate and produce fertile offspring with each other. At that point, they are classified as separate species.

**Q222. Why can species no longer interbreed if they have become too different in phenotype?**
**Answer:** If species become too different in phenotype, it often means their genes have also changed too much. Their bodies may not be compatible for mating, or the offspring may not survive or be fertile. These differences prevent them from producing healthy offspring together, which means they are now separate species with their own unique traits.

**Q223. How does natural selection explain the evolution of antibiotic resistance in bacteria?**
**Answer:** When antibiotics are used, most bacteria are killed, but some may have a mutation that makes

them resistant. These resistant bacteria survive and reproduce, passing on the resistance gene. Over time, the population becomes mostly resistant. This is natural selection—bacteria with useful traits survive and pass on their genes, leading to evolution of antibiotic resistance.

**Q224. Give an example of a species that has evolved due to environmental pressures.**
**Answer:** The peppered moth is a good example. Before industrial pollution, light-coloured moths blended in with tree bark and survived better. After pollution darkened the trees, dark-coloured moths had an advantage and became more common. This change in population due to environmental pressure is an example of natural selection and evolution.

**Q225. Why is the theory of evolution by natural selection widely accepted today?**
**Answer:** The theory of evolution by natural selection is widely accepted because it is supported by a large amount of evidence from many areas of science. Fossil records, genetic studies, and observations of natural selection in action all support it. Over time, scientists have tested and confirmed the theory many times, making it one of the most reliable explanations for how life on Earth has changed.

**Q226. What evidence supports the theory of evolution?**
**Answer:** The theory of evolution is supported by many types of evidence. Fossils show how organisms have changed over time, with simpler life forms in older rocks and more complex ones in newer rocks. DNA studies show that all living things share some genetic material, suggesting common ancestry. Observations of natural selection, like antibiotic resistance in bacteria or changes in animal populations, also support how species evolve over generations.

**Q227. What does it mean when we say all species have evolved from simple life forms?**
**Answer:** This means that all plants, animals, and microorganisms alive today came from very simple living things that first appeared billions of years ago. These early life forms were basic, single-celled organisms. Over time, they changed and became more complex through evolution. As these life forms reproduced, mutations and natural selection led to the wide variety of species we see now.

**Q228. How long ago did the first simple life forms appear on Earth?**
**Answer:** Scientists believe the first simple life forms appeared on Earth about 3.5 billion years ago. These early organisms were probably single-celled and lived in water. They had very basic structures and reproduced asexually. Over a very long time, these organisms evolved into more complex life forms through natural selection and the process of evolution.

**Q229. Why is evolution a gradual process over many generations?**
**Answer:** Evolution takes place slowly because it depends on small changes in genes, called mutations, which occur randomly. These changes may give some individuals an advantage. If they survive and reproduce, they pass on their traits. Over many generations, these small changes build up, leading to major differences. Since organisms live for years and reproduce slowly, evolution needs a long time to show big results.

**Q230. Describe the steps involved in the process of selective breeding.**
**Answer:** Selective breeding starts by choosing two parent organisms with desired traits. These parents are

bred together to produce offspring. The best offspring showing the desired traits are then selected and bred again. This process is repeated for many generations until the trait becomes fixed in the population. This method is used to improve crops, animals, or other useful organisms.

**Q231. How is selective breeding different from natural selection?**
**Answer:** In selective breeding, humans choose which individuals to breed based on desired traits, such as size or colour. Natural selection happens without human involvement—organisms with traits that help them survive in their environment are more likely to reproduce. So, selective breeding is controlled by humans, while natural selection is driven by nature and survival needs.

**Q232. Why do humans use selective breeding in farming?**
**Answer:** Humans use selective breeding in farming to improve the quality and quantity of crops and animals. For example, they may breed cows that give more milk or plants that grow larger fruits. This helps farmers produce more food, make farming more efficient, and increase profits. Selective breeding also helps develop disease-resistant plants or animals that grow faster.

**Q233. Give one example of a characteristic that may be selected in food crops.**
**Answer:** One example is selecting crops for high yield. Farmers may choose plants that produce more fruit or grains and breed them to increase overall food production. Other characteristics include resistance to pests, faster growth, or better taste. These traits help improve farming success and provide better-quality food for people.

**Q234. What characteristic might a farmer want in animals that produce milk?**
**Answer:** A farmer would want animals that produce large amounts of milk, like dairy cows with high milk yield. They may also look for cows that produce milk with higher fat content or better quality. Other desired traits include good health, calm behaviour, and strong bodies to reduce injury and disease. These traits help increase milk production and reduce costs.

**Q235. Why might people selectively breed domestic dogs?**
**Answer:** People selectively breed dogs to develop specific traits such as appearance, behaviour, or abilities. For example, some dogs are bred to be friendly pets, others to guard homes, or to assist people with disabilities. Breeding can also improve size, coat type, or intelligence. However, breeding for extreme traits can sometimes cause health problems in dogs.

**Q236. How does selective breeding affect the appearance of flowers?**
**Answer:** Selective breeding can change flower appearance by selecting for traits like colour, size, scent, or petal shape. Gardeners or farmers choose plants with the most attractive features and cross them. Over time, this leads to flowers with brighter colours, bigger blooms, or stronger smells. This process is often used to make flowers more appealing for sale or decoration.

**Q237. What are the risks of inbreeding in selectively bred animals?**
**Answer:** Inbreeding happens when closely related animals are bred together. This increases the chance of inheriting harmful genetic conditions because similar genes are more likely to be passed on. It can lead to

weak immune systems, deformities, reduced fertility, and shorter lifespans. Over time, the overall health and survival of the animals may be affected.

**Q238. Why can inbreeding lead to health problems in offspring?**
**Answer:** Inbreeding increases the risk of inheriting two copies of harmful recessive alleles, which can cause genetic diseases. Since the parents share many of the same genes, their offspring are more likely to get faulty genes from both sides. This can lead to problems such as joint issues, heart defects, or weakened immune systems, especially in animals like dogs or farm livestock.

**Q239. What is an inherited defect and how can it result from inbreeding?**
**Answer:** An inherited defect is a health problem passed down through genes from parents to offspring. Inbreeding increases the chance of two copies of the same faulty gene coming together, which can cause these defects. Examples include blindness, breathing problems, or weak bones. These defects may reduce the animal's quality of life and may be hard to treat or prevent once they appear.

**Q240. How does selective breeding reduce genetic variation in a population?**
**Answer:** Selective breeding involves choosing only a few individuals with certain traits to reproduce. This means other genes are not passed on, and the gene pool becomes smaller. Over time, this reduces genetic variation in the population. With less variety, the group may struggle to adapt to changes, and harmful traits may become more common, increasing the risk of diseases or poor health.

**Q241. Why might low genetic variation be a problem for a species?**
**Answer:** Low genetic variation means fewer differences in genes within the species. This makes the population less able to adapt to changes like new diseases, climate change, or environmental stress. If all individuals are similar, they might all be affected by the same problem. This can lead to a decline in numbers or even extinction if they can't survive or reproduce.

**Q242. What ethical concerns might arise from selective breeding?**
**Answer:** Ethical concerns include causing health problems in animals bred for extreme traits, such as breathing issues in flat-faced dogs. There are also worries about reducing animal welfare and ignoring their natural behaviours. Some people think it is wrong to interfere too much with nature or to treat animals like objects. In farming, focusing only on production may also harm animal well-being.

**Q243. How can selective breeding help increase food supply?**
**Answer:** Selective breeding helps increase food supply by producing crops and animals that grow faster, give higher yields, or resist disease. For example, wheat can be bred to produce more grain, or chickens that lay more eggs. These improvements help farmers produce more food using the same space, reduce losses, and ensure more reliable harvests, especially in areas where food is limited.

**Q244. Give an example of a success in agriculture due to selective breeding.**
**Answer:** One example is the development of high-yield wheat. Through selective breeding, scientists created wheat plants that grow quickly, resist diseases, and produce large amounts of grain. This has helped feed growing populations and improve food security in many countries. Another example is breeding cows that produce more milk, helping farmers increase dairy production efficiently.

**Q245. What could be a consequence of selective breeding plants with low genetic diversity?**
**Answer:** If plants have low genetic diversity, they are more likely to be wiped out by a single disease or pest. Since all the plants are genetically similar, they may all be vulnerable to the same problem. This can lead to huge crop failures and food shortages. It also makes it harder for the plants to adapt to climate change or new environmental conditions.

**Q246. How does selective breeding affect evolution in the long term?**
**Answer:** Selective breeding changes the traits of a population by favouring certain genes chosen by humans. Over time, this leads to changes in the gene pool and causes evolution in a specific direction. Unlike natural selection, it doesn't always produce traits that help survival in the wild. In the long term, it may limit adaptability and reduce fitness if traits are chosen only for human use.

**Q247. Why must selected individuals be bred over many generations to fix a trait?**
**Answer:** Fixing a trait takes many generations because genes are passed randomly. Even if a parent has a desired trait, not all offspring will show it. By selecting and breeding only the best individuals again and again, the trait becomes more common and eventually appears in almost all offspring. This process helps to make the trait stable and permanent in the population.

**Q248. How can selective breeding be used to increase disease resistance in crops?**
**Answer:** Farmers and scientists can identify plants that survive diseases better and breed them with others. Offspring that inherit the resistance are then selected and bred again. Over time, the population becomes more resistant to the disease. This reduces the need for chemical sprays and helps ensure stable food production, even during outbreaks.

**Q249. What is one social concern related to breeding animals for extreme traits?**
**Answer:** One social concern is that breeding animals for extreme traits, like very flat faces or very short legs, can cause suffering. These traits may look appealing but often lead to health problems. People worry this shows a lack of respect for animal welfare. There is also concern about encouraging unrealistic standards for appearance, which could influence how animals and people are treated.

**Q250. Explain why farmers might choose to avoid inbreeding in livestock.**
**Answer:** Farmers avoid inbreeding because it can cause health problems and reduce productivity. Inbred animals may have weaker immune systems, more defects, and lower fertility. These problems increase costs and reduce profits. By using animals from different families or breeds, farmers can maintain strong, healthy livestock with better growth, survival, and ability to resist disease.

**Q251. What is genetic engineering and what is its main purpose?**
**Answer:** Genetic engineering is a process where scientists change the DNA of an organism by adding, removing, or altering specific genes. The main purpose is to give the organism new traits that are useful, such as making crops resistant to pests or producing medicines in bacteria. It allows genes from one species to be inserted into another, even if they are completely different types of organisms.

**Q252. How is a gene from one organism transferred to another during genetic engineering?**
**Answer:** A gene from one organism is first identified and cut out using special enzymes. It is then inserted

into the DNA of another organism using a vector, such as a virus or a plasmid. The modified DNA is then placed into the target cells, often at an early stage of development, so that as the organism grows, all its cells contain the new gene and show the new trait.

**Q253. What is a genetically modified (GM) crop?**
**Answer:** A genetically modified (GM) crop is a plant that has had its DNA changed using genetic engineering techniques. Scientists add genes from other organisms to give the crop useful traits, such as resistance to pests, diseases, or herbicides. GM crops are developed to improve farming by making crops more productive or better suited to different conditions.

**Q254. Give two examples of desirable traits introduced into GM crops.**
**Answer:** One example is insect resistance, where genes from bacteria are added to help the crop kill certain pests. Another example is herbicide resistance, which allows farmers to spray weeds without harming the crop. These traits help protect the crop, reduce losses, and improve food production. Some GM crops are also made to survive drought or improve nutritional content.

**Q255. How can genetic engineering increase crop yields?**
**Answer:** Genetic engineering can make crops more resistant to pests, diseases, and harsh weather, which helps reduce damage and loss. Some GM crops can grow faster or produce more food. By making crops healthier and more efficient, farmers can harvest more from the same area of land. This increases food supply and helps meet the needs of growing populations.

**Q256. What are the potential benefits of genetically modified crops?**
**Answer:** GM crops can grow faster, resist pests and diseases, need fewer chemicals, and survive harsh weather. This makes farming more efficient and helps produce more food. Some GM crops also have added nutrients to fight malnutrition. They can be useful in countries with poor soil or limited water, and may help reduce food shortages and farming costs.

**Q257. Why might GM crops be helpful in countries with food shortages?**
**Answer:** GM crops can be designed to grow in poor soil, resist pests, and survive drought, which are common problems in countries with food shortages. They can also produce higher yields and require fewer resources, like water or pesticides. This helps farmers grow more food even in difficult conditions, which can improve food security and reduce hunger.

**Q258. What are some concerns people have about eating GM foods?**
**Answer:** Some people worry that GM foods might cause allergies or unknown health problems. Others are concerned that not enough is known about the long-term effects. Some believe GM foods could harm the environment or reduce natural biodiversity. There are also ethical concerns about changing the DNA of living things and how these changes are controlled or labelled.

**Q259. How might GM crops affect wild plants and animals?**
**Answer:** GM crops could affect wild plants and animals if the genes spread into the wild. For example, a gene for herbicide resistance might pass to weeds, creating "superweeds" that are hard to control. GM crops

could also harm insects that are not pests or affect animals that feed on them. This could upset the natural balance and reduce biodiversity.

**Q260. Why is it important to test the long-term effects of GM foods?**
**Answer:** Testing the long-term effects of GM foods is important to make sure they are safe for people and the environment. Some effects may not be seen right away, such as health risks or ecological damage. Long-term testing helps scientists understand any risks and ensure that GM foods do not cause harm before they are widely used in farming or sold to consumers.

**Q261. How is genetic engineering used in medicine?**
**Answer:** Genetic engineering is used in medicine to produce useful substances like insulin and human growth hormone. It can also be used to develop vaccines or to create genetically modified cells for treating diseases. In the future, gene therapy may allow doctors to fix faulty genes in patients to cure inherited disorders. It plays a key role in modern medical research and treatments.

**Q262. Give one example of a useful product made using genetically engineered bacteria.**
**Answer:** A useful product made using genetically engineered bacteria is human insulin. Scientists insert the human insulin gene into bacteria, which then produce insulin in large amounts. This insulin is collected and purified for use by people with diabetes. It is a reliable, safe, and low-cost way to produce the insulin that millions of patients need to survive.

**Q263. Why is insulin produced by genetically modified bacteria important?**
**Answer:** Insulin from genetically modified bacteria is important because it provides a safe and cheap supply of human insulin for people with diabetes. Before this, insulin had to be taken from animals, which was more expensive and sometimes caused allergic reactions. Now, GM bacteria make insulin that is identical to human insulin, making treatment easier and more effective.

**Q264. What are some benefits of using genetic engineering in medicine?**
**Answer:** Genetic engineering in medicine can help produce drugs and hormones quickly and cheaply, like insulin or growth hormone. It can be used to develop better vaccines or personalised treatments. In the future, gene therapy may cure inherited diseases by correcting faulty genes. It also helps scientists study diseases more closely, leading to better understanding and treatments.

**Q265. What are the possible risks of genetic engineering in humans?**
**Answer:** Risks of genetic engineering in humans include unexpected side effects, such as triggering other health problems or causing the gene to affect the wrong part of the body. There are also worries about accidentally changing genes in future generations. Some people fear it could be used unethically, such as choosing physical traits in babies instead of just curing diseases.

**Q266. Why do some people object to genetic engineering?**
**Answer:** Some people object to genetic engineering for religious or ethical reasons, believing it is wrong to change the natural genes of living things. Others worry about the long-term effects on health or the environment. There are also concerns about fairness, such as rich people using gene editing for personal advantage while others cannot afford it.

**Q267. What role do enzymes play in the process of genetic engineering?**
**Answer:** Enzymes are used to cut and join DNA during genetic engineering. Restriction enzymes are used to cut out the desired gene from one organism. Ligase enzymes help join this gene into the DNA of another organism. These enzymes are important tools in moving genes between organisms and making sure the new gene is inserted correctly into the target DNA.

**Q268. What is a vector in genetic engineering?**
**Answer:** A vector is a tool used to carry a gene from one organism into another. It helps deliver the gene into the cells that need to be modified. The vector protects the gene and helps it enter the DNA of the target organism. Vectors are very important in making sure the new gene gets into the correct place and works properly.

**Q269. Give two examples of vectors used in genetic engineering.**
**Answer:** Two common vectors used in genetic engineering are plasmids and viruses. Plasmids are small circular pieces of DNA found in bacteria, which can carry and insert new genes. Viruses can also be used to deliver genes by infecting cells and inserting the desired DNA. Both are useful for introducing new traits into cells or organisms.

**Q270. Why are genes transferred at an early stage of development in genetic engineering?**
**Answer:** Genes are transferred at an early stage so that the new gene is present in all the cells as the organism develops. This ensures that the trait controlled by the gene appears throughout the whole body. If the gene is added later, only some cells may have it, and the trait may not be fully shown. Early transfer is key for the change to be permanent and complete.

**Q271. How does transferring genes early affect the whole organism?**
**Answer:** Transferring genes early means the gene becomes part of every cell as the organism grows. This ensures the new trait is present in the entire body, not just in a few cells. It makes the genetic change stable and long-lasting. The new trait can also be passed on to offspring if the gene is present in reproductive cells.

**Q272. What ethical questions are raised by genetic engineering in humans?**
**Answer:** Ethical questions include whether it is right to change human DNA, especially if the changes can be passed to future generations. People worry about choosing traits like intelligence or appearance, which could lead to inequality or discrimination. There are also concerns about safety, consent, and whether it is fair for only some people to benefit from these technologies.

**Q273. How might genetic engineering be used to treat inherited disorders in the future?**
**Answer:** In the future, genetic engineering might be used to treat inherited disorders by replacing or fixing faulty genes in a person's cells. This is called gene therapy. For example, scientists could add a working copy of a gene to someone with a genetic disease. If successful, this could cure the disease at its root, rather than just treating the symptoms.

**Q274. What is tissue culture in plants and why is it used?**
**Answer:** Tissue culture is a method of growing new plants from a few cells or tissues of a parent plant in a special nutrient-rich jelly. It is used because it can quickly produce many identical plants. This is helpful for

growing plants with desirable traits, saving rare species, or producing disease-free plants. It allows for large-scale, efficient reproduction of plants.

**Q275. How does tissue culture help preserve rare plant species?**
**Answer:** Tissue culture helps preserve rare plant species by allowing many new plants to be grown from just a few cells. This is useful when only a small number of the species are left. By growing more plants in safe conditions, scientists can protect them from extinction and later replant them in the wild. It's a way of saving and restoring endangered plant populations.

**Q276. Describe the method of cloning plants using cuttings.**
**Answer:** Cloning plants using cuttings involves taking a part of a healthy parent plant, such as a stem, leaf, or root, and placing it in soil or water where it can grow roots. The cutting will develop into a new plant that is genetically identical to the parent. This is a simple and cheap method of cloning used by gardeners and farmers to grow more plants quickly with the same features as the original.

**Q277. What are the benefits of cloning plants through cuttings for gardeners?**
**Answer:** Cloning through cuttings is quick, cheap, and does not need special equipment. It allows gardeners to grow many identical plants with good qualities, like strong flowers or tasty fruits. It also ensures the new plants keep the exact traits of the parent plant. This is helpful if the gardener wants to preserve a successful plant or grow more of a rare variety.

**Q278. What is embryo transplant cloning in animals?**
**Answer:** Embryo transplant cloning in animals involves taking an embryo formed from fertilisation and splitting it into separate cells very early in its development. Each of these cells can grow into a separate but genetically identical animal. These embryos are then implanted into surrogate mothers to develop. This method is often used to produce animals with desirable traits.

**Q279. Why are embryos split early in development during embryo transplant cloning?**
**Answer:** Embryos are split early because at this stage the cells are not yet specialised and each one can still develop into a complete organism. By separating them early, scientists can grow multiple identical animals from a single fertilised egg. This ensures that the resulting clones will all have the same genetic makeup, giving predictable and uniform traits.

**Q280. What is the result of cloning an animal using embryo transplant techniques?**
**Answer:** The result is several animals that are genetically identical to each other but not necessarily identical to the parents, since the original embryo came from sexual reproduction. These cloned animals will have the same features, such as growth rate or milk production, and are useful in farming or scientific research where uniform animals are needed.

**Q281. Describe the steps involved in adult cell cloning.**
**Answer:** In adult cell cloning, the nucleus from a body cell of the animal to be cloned is taken and inserted into an unfertilised egg cell that has had its nucleus removed. An electric shock is used to make the egg cell start dividing like a normal embryo. This embryo is then implanted into a surrogate mother, where it grows and develops into a clone of the animal that donated the body cell.

**Q282. Why is the nucleus removed from an unfertilised egg in adult cell cloning?**
**Answer:** The nucleus is removed from the egg so that it does not contain any of its original DNA. This way, the only genetic information in the egg will come from the adult body cell that is being cloned. This ensures the resulting organism is an exact genetic copy of the donor animal, not a mix of two sets of genes.

**Q283. What is the purpose of using an electric shock in adult cell cloning?**
**Answer:** The electric shock is used to stimulate the egg cell to start dividing and behaving like a fertilised egg. This begins the process of embryo development. Without the shock, the egg would not recognise the inserted nucleus as normal and would not divide. The shock helps start the cloning process and allows the embryo to grow normally.

**Q284. Why do the offspring in adult cell cloning have the same genes as the donor?**
**Answer:** The offspring have the same genes as the donor because the DNA in the egg comes entirely from the donor's body cell. The egg's original nucleus, which contains its DNA, is removed, and the donor's nucleus is used instead. This means the cloned animal has identical genetic material to the animal that donated the body cell.

**Q285. Where is the developing embryo placed during adult cell cloning?**
**Answer:** The developing embryo is placed into the womb of a surrogate animal, where it can continue to grow just like a normal pregnancy. The surrogate carries the embryo to term and gives birth to the cloned animal. The surrogate does not pass on any genes to the clone; it only provides the environment for development.

**Q286. What are the possible benefits of cloning in farming?**
**Answer:** Cloning in farming allows farmers to produce animals with desirable traits, such as high milk production, good meat quality, or disease resistance. Once a good animal is found, cloning ensures many more can be made with the exact same traits. This helps improve efficiency and productivity. Cloning can also help preserve rare or endangered breeds.

**Q287. How could cloning help protect endangered species?**
**Answer:** Cloning can help protect endangered species by creating new individuals from limited genetic material. If only a few animals are left, cloning can increase their numbers. Scientists can use cells from living animals or even preserved ones to make embryos and implant them into similar species. This may help rebuild populations and prevent extinction.

**Q288. What are the risks of using cloning in agriculture?**
**Answer:** Risks include reducing genetic variation, which makes crops or animals more vulnerable to diseases or environmental changes. If all clones are genetically identical, one disease could affect them all. Cloning may also lead to health problems in animals, such as birth defects or shorter lifespans. Ethical concerns about animal welfare are also common.

**Q289. How could animal cloning reduce genetic diversity?**
**Answer:** Cloning makes many animals with exactly the same genes. If only a few individuals are cloned repeatedly, the overall variety of genes in the population goes down. This reduced genetic diversity makes the

population less able to adapt to new diseases or changing environments and can increase the chances of inherited diseases becoming more common.

**Q290. Why do some people oppose the cloning of animals?**
**Answer:** Some people believe cloning is unnatural and may harm animal welfare. They worry about the suffering of cloned animals, such as birth defects or early death. Others are concerned that cloning reduces biodiversity and could be misused for profit. Ethical concerns include treating animals as products rather than living beings with needs and rights.

**Q291. What are the ethical issues around cloning human embryos?**
**Answer:** Ethical issues include concerns about creating human life in a lab and possibly destroying embryos during research. Some people believe it is wrong to use embryos this way, as they consider them potential human lives. There are also worries about cloning being used for non-medical reasons, such as choosing a baby's appearance, which could lead to inequality or misuse.

**Q292. Why might some people support cloning in medicine?**
**Answer:** Some people support cloning in medicine because it could help treat diseases and save lives. For example, cloned cells could be used to repair damaged organs or tissues, or to grow organs for transplants. Cloning might also help study diseases more closely. Supporters believe that if it is used carefully, cloning can bring big benefits to human health.

**Q293. How could cloning be used to create genetically identical animals for drug testing?**
**Answer:** Cloning can be used to make animals that are exactly the same genetically, so they respond the same way to a drug. This helps scientists test new medicines more accurately because differences between animals are reduced. This makes the results more reliable and helps researchers know if the drug works or has side effects before trying it on humans.

**Q294. What are the differences between sexual reproduction and cloning?**
**Answer:** In sexual reproduction, two parents pass on a mix of their genes, creating offspring with genetic variation. In cloning, there is only one parent and the offspring is genetically identical to that parent. Sexual reproduction leads to differences between individuals, while cloning produces exact copies. Cloning is a type of asexual reproduction with no genetic mixing.

**Q295. Why is cloning considered a form of asexual reproduction?**
**Answer:** Cloning is considered asexual reproduction because it involves only one parent and produces offspring that are genetically identical to that parent. There is no joining of sperm and egg, and no mixing of genes. The new organism is made using the exact same DNA as the parent, just like in natural asexual reproduction in some plants and animals.

**Q296. What makes cloning different from selective breeding?**
**Answer:** In selective breeding, two parents are chosen for their good traits, and their offspring are a mix of both parents' genes. Over generations, this can improve traits. Cloning, however, creates an exact copy of one individual with no genetic mixing. Selective breeding allows some variation, while cloning keeps the genes exactly the same.

**Q297. How can cloning help in studying the effects of genes?**
**Answer:** Cloning can help scientists study genes by allowing them to see how certain genes affect growth, health, or behaviour in identical animals. If all the animals are clones, differences between them must come from the environment, not genes. This makes it easier to understand which traits are controlled by genes and how they work.

**Q298. Why might clones be more likely to suffer from inherited diseases?**
**Answer:** Clones have exactly the same DNA as the donor. If the donor has a faulty gene that causes a disease, the clone will also have it. Since there is no genetic variation, clones can't avoid passing on harmful genes. If many clones are made from one animal with a genetic defect, they will all likely suffer the same problems.

**Q299. What is the advantage of producing many identical plants in agriculture?**
**Answer:** Producing identical plants means all of them will have the same useful traits, such as high yield, good taste, or disease resistance. This makes farming more reliable and efficient. Farmers can be sure of the crop's quality and performance. It also makes it easier to manage large farms, as all plants will need the same care and grow in the same way.

**Q300. Explain how cloning might be useful in medical research.**
**Answer:** Cloning can help in medical research by creating identical animals or cells for experiments. This makes it easier to study how diseases develop or how treatments work. Scientists can also clone cells with certain diseases to test drugs. In the future, cloning might be used to grow tissues or organs for transplant, or to repair damaged body parts using a person's own cells.

**Q301. Who proposed the theory of evolution by natural selection and what influenced his ideas?**
**Answer:** The theory of evolution by natural selection was proposed by Charles Darwin. His ideas were influenced by his travels on the HMS Beagle, especially his observations of different species on the Galápagos Islands. He noticed variations in similar animals adapted to different environments. He also studied fossils and was influenced by the ideas of other scientists like Lyell and Malthus.

**Q302. What observations did Darwin make that led to his theory of natural selection?**
**Answer:** Darwin observed that there was variation in traits among individuals of the same species, and that more offspring were born than could survive. He noticed that some individuals had traits that made them better suited to their environment and were more likely to survive and reproduce. Over time, these helpful traits became more common in the population.

**Q303. Why was there controversy around Darwin's theory when it was first published?**
**Answer:** Darwin's theory was controversial because it went against religious beliefs at the time that said God created all living things as they are. People also struggled with the idea that humans shared ancestors with animals. Additionally, there was little understanding of genetics, so scientists couldn't explain how traits were passed on, which made some people doubt his theory.

**Q304. What role did fossils and geology play in supporting Darwin's theory?**
**Answer:** Fossils showed that life on Earth had changed over time, with simpler organisms found in older

rocks and more complex ones in newer layers. Geology showed that the Earth was very old, giving enough time for gradual changes to occur. These findings supported Darwin's idea that species evolve slowly through small changes over long periods.

**Q305. How does variation within a species help in natural selection?**
**Answer:** Variation means that individuals in a species are not all the same. Some may have traits that help them survive better in their environment. These individuals are more likely to live long enough to reproduce and pass on their helpful traits. Without variation, natural selection wouldn't have different traits to "select" from, and evolution wouldn't happen.

**Q306. Why are organisms with beneficial characteristics more likely to survive and reproduce?**
**Answer:** Organisms with beneficial characteristics are better suited to their environment. This means they can find food more easily, avoid predators, or survive harsh conditions. Because they survive longer, they have more chances to reproduce and pass on their traits to their offspring, making those traits more common in the next generation.

**Q307. How are useful characteristics passed to the next generation according to natural selection?**
**Answer:** Useful characteristics are passed on through genes. When organisms with helpful traits survive and reproduce, they pass the genes for those traits to their offspring. Over many generations, these traits become more common in the population, especially if they continue to help the organism survive in its environment.

**Q308. What is the title of Darwin's famous book and when was it published?**
**Answer:** Darwin's famous book is called *On the Origin of Species*. It was published in 1859. In this book, he explained his theory of evolution by natural selection and provided evidence from his research and observations during his travels around the world, including the Galápagos Islands.

**Q309. Why was Darwin's theory not fully accepted when it was first introduced?**
**Answer:** Darwin's theory was not fully accepted at first because many people believed in creation as described in religious texts. Scientists also did not yet understand genetics, so they couldn't explain how traits were inherited. Some people found it hard to believe that small changes over time could lead to entirely new species.

**Q310. What was not understood at the time of Darwin's theory that made it difficult to prove?**
**Answer:** At the time, scientists didn't understand how inheritance worked. Genes and DNA had not yet been discovered, so Darwin couldn't explain how traits were passed from parents to offspring. Without this knowledge, it was hard to provide full scientific proof for how natural selection led to evolution.

**Q311. What is Lamarck's theory of evolution and why is it now rejected?**
**Answer:** Lamarck's theory suggested that organisms could change during their lifetime by using or not using parts of their bodies, and that these changes could be passed to their offspring. For example, he believed giraffes stretched their necks and passed longer necks to their babies. This theory is now rejected because we know traits are passed through genes, not by use or disuse.

**Q312. Give an example of an idea from Lamarck's theory.**
**Answer:** An example from Lamarck's theory is the idea that giraffes developed long necks because they stretched to reach leaves on tall trees. He believed this stretching made their necks longer and that the trait was passed to their young. Modern science has shown that traits are inherited through DNA, not by actions taken during life.

**Q313. What does current science say about inheritance of acquired characteristics?**
**Answer:** Current science says that acquired characteristics, like muscle from exercise or a scar from injury, are not passed on to offspring because they do not change the DNA. Only genetic traits passed through DNA in sex cells can be inherited. This is why Lamarck's idea that acquired traits are passed on is considered incorrect.

**Q314. Who was Alfred Russel Wallace and what did he contribute to the theory of evolution?**
**Answer:** Alfred Russel Wallace was a scientist who independently developed a theory of evolution by natural selection at the same time as Darwin. He sent his ideas to Darwin in a letter. Their ideas were published together in 1858. Wallace's work supported Darwin's theory and helped encourage Darwin to publish his own findings.

**Q315. When did Wallace and Darwin publish their joint ideas on evolution?**
**Answer:** Wallace and Darwin's joint ideas were first presented in 1858 at a meeting of the Linnean Society in London. Their work was published in the society's journal that same year. This was before Darwin released his famous book *On the Origin of Species* in 1859.

**Q316. What part of evolution did Wallace do most of his research on?**
**Answer:** Wallace did most of his research on natural selection and how it leads to the formation of new species, especially due to geographical isolation. He also studied the role of environmental pressures and developed strong ideas about how animals adapted to their environments, particularly in tropical regions.

**Q317. What is warning colouration and why did Wallace study it?**
**Answer:** Warning colouration is when animals have bright colours to warn predators that they are poisonous or dangerous. Wallace studied this because it supported natural selection. Animals with warning colours are avoided by predators and survive longer, so they pass on their traits. This helps explain how such adaptations evolve.

**Q318. How did Wallace's work support Darwin's theory of evolution?**
**Answer:** Wallace's observations and ideas closely matched Darwin's theory of natural selection. His studies of animals in different parts of the world showed that species changed to suit their environments. His work on warning colouration and isolation helped provide further evidence that species evolve due to environmental pressures.

**Q319. Why did Darwin publish his book shortly after Wallace sent him a letter?**
**Answer:** Darwin published his book soon after Wallace sent him a letter because he realised that someone else had come up with the same idea. Although Darwin had been working on his theory for years, Wallace's

letter pushed him to publish his research before someone else claimed the discovery. They both shared credit for the theory.

**Q320. How has our understanding of speciation improved since Wallace's time?**
**Answer:** Since Wallace's time, we have learned more about DNA, genetics, and how traits are inherited. We understand better how isolation, mutation, and natural selection work together to form new species. Advances in technology, such as gene sequencing, help scientists study how species split and evolve over time.

**Q321. What is speciation?**
**Answer:** Speciation is the process by which new species are formed. It happens when a group of organisms becomes so different from another group that they can no longer breed and produce fertile offspring. This can occur due to isolation, mutation, and natural selection acting over many generations.

**Q322. What is the first step in the process of speciation?**
**Answer:** The first step in speciation is isolation. This usually means that part of a population becomes separated from the rest, often by a physical barrier like a mountain, river, or distance. Once isolated, the groups stop breeding with each other, allowing differences to develop over time.

**Q323. How does geographical isolation lead to speciation?**
**Answer:** Geographical isolation prevents two groups of the same species from breeding. Over time, each group experiences different environmental conditions and mutations. Natural selection causes the best traits for each environment to become more common. Eventually, the groups become so different they can no longer interbreed, forming new species.

**Q324. Why does natural selection act differently in isolated populations?**
**Answer:** In isolated populations, the environment may be different, so the challenges for survival are not the same. For example, one group might face cold weather while the other lives in a dry desert. Natural selection favours different traits in each environment, causing the groups to change in different ways over time.

**Q325. What must happen for two groups to be considered separate species?**
**Answer:** Two groups are considered separate species when they can no longer breed together to produce fertile offspring. This means their genetic differences have become too great. Even if they are brought back together, if they cannot successfully reproduce, they are classed as different species.

**Q326. Why can't members of different species produce fertile offspring?**
**Answer:** Members of different species usually can't produce fertile offspring because their DNA is too different. Their chromosomes may not match properly, so the offspring, if produced, are often infertile or unable to survive. For example, a horse and a donkey can produce a mule, but mules are usually infertile because the number of chromosomes from the two parent species doesn't allow normal reproduction.

**Q327. How can environmental changes lead to the formation of new species?**
**Answer:** Environmental changes can lead to the formation of new species by creating new conditions where only certain traits help organisms survive. If a group of the same species becomes separated and lives in

different environments, natural selection will favour different traits in each group. Over time, the groups become so different that they can no longer breed together, resulting in new species.

**Q328. What is reproductive isolation and how does it contribute to speciation?**
**Answer:** Reproductive isolation happens when two groups of the same species can no longer interbreed. This can be due to physical barriers, different mating behaviours, or timing of reproduction. Because they don't mix their genes anymore, they evolve separately. Over many generations, the genetic differences grow so large that they become separate species.

**Q329. How did Wallace's fieldwork help build evidence for evolution?**
**Answer:** Wallace's fieldwork in places like the Amazon and Southeast Asia allowed him to observe many species and how they adapted to their environments. He noticed that animals in different locations developed different traits depending on their surroundings. His observations of things like warning colouration and geographic separation gave strong evidence for natural selection and the development of new species.

**Q330. What impact did the theory of natural selection have on the field of biology?**
**Answer:** The theory of natural selection changed biology by explaining how species change and evolve over time without needing a designer. It showed how small changes could add up to big differences, leading to the diversity of life. It helped scientists understand relationships between organisms and laid the foundation for fields like genetics, ecology, and evolution.

**Q331. Who was Gregor Mendel and what experiments did he carry out?**
**Answer:** Gregor Mendel was an Austrian monk who is known as the father of genetics. He carried out experiments on pea plants in the 1800s. He studied how traits like flower colour and seed shape were passed from one generation to the next. By carefully breeding plants and counting the traits in offspring, he discovered patterns in inheritance that are still used today.

**Q332. What was Mendel's main discovery about inheritance?**
**Answer:** Mendel discovered that traits are passed from parents to offspring through "units," now called genes. He found that some traits are dominant and others are recessive. A trait may not appear in one generation but can reappear in the next. This showed that inheritance follows specific rules and is not just a blend of parental features.

**Q333. What term did Mendel use to describe inherited characteristics?**
**Answer:** Mendel used the word "factors" to describe the inherited units that control traits. He noticed that these factors came in pairs, one from each parent, and they could be either dominant or recessive. Today, we call these factors "genes," and Mendel's work forms the basis of our understanding of how traits are inherited.

**Q334. Why was Mendel's work not recognised during his lifetime?**
**Answer:** Mendel's work was not recognised during his lifetime because the science of genetics didn't exist yet. Other scientists didn't understand the importance of his findings, and his work was published in a little-known journal. Also, people still believed in blending inheritance, so his ideas didn't fit with common thinking at the time.

**Q335. When did scientists begin to accept Mendel's ideas and why?**
**Answer:** Scientists began to accept Mendel's ideas in the early 1900s, around 1900, after other researchers repeated his experiments and got similar results. At the same time, scientists discovered chromosomes, and they saw that Mendel's "factors" acted like genes on chromosomes. This helped explain how inheritance works and led to the beginning of modern genetics.

**Q336. What role did the discovery of chromosomes play in genetics?**
**Answer:** The discovery of chromosomes helped scientists understand how genes are passed from parents to offspring. Chromosomes carry DNA and genes, and they come in pairs. During reproduction, they are divided and passed on, just like Mendel's "factors." This gave a physical explanation for inheritance and supported the patterns Mendel had discovered.

**Q337. How did the behaviour of chromosomes support Mendel's ideas?**
**Answer:** Chromosomes behave in ways that match Mendel's ideas. During meiosis, chromosomes are separated and passed on to offspring, one from each parent. This matches how Mendel said that traits are inherited in pairs and separated during reproduction. The discovery of how chromosomes move during cell division helped prove Mendel's theory.

**Q338. What did scientists conclude about Mendel's units in the early 20th century?**
**Answer:** In the early 20th century, scientists concluded that Mendel's "units" were actually genes, and that they are located on chromosomes. This helped connect Mendel's work with the new discoveries in cell biology and gave a deeper understanding of how inheritance works. It was the beginning of the science we now call genetics.

**Q339. When was the structure of DNA discovered?**
**Answer:** The structure of DNA was discovered in 1953 by James Watson and Francis Crick. They found that DNA has a double helix shape. Their discovery showed how genetic information is stored and copied in living organisms. It explained how traits are passed on and how mutations can lead to changes in genes.

**Q340. Why was the discovery of DNA structure important for understanding inheritance?**
**Answer:** Discovering the structure of DNA helped scientists understand exactly how genes work. The double helix explained how DNA is copied during cell division and how the code in DNA controls traits. It also helped explain mutations and how they can lead to genetic disorders. This discovery made inheritance easier to study at the molecular level.

**Q341. What is the gene theory and how did it develop?**
**Answer:** The gene theory says that traits are controlled by genes, which are made of DNA and found on chromosomes. This idea developed from Mendel's work on inheritance and later discoveries about chromosomes and DNA. As scientists learned more about how DNA works, they saw that genes are the basic units of heredity, controlling how organisms grow and function.

**Q342. How has the gene theory changed the way we study biology?**
**Answer:** Gene theory has made biology more focused on understanding how traits are controlled at the molecular level. It helps scientists study diseases, develop new medicines, and improve crops and animals

through genetic engineering. It also allows for genetic testing, research into evolution, and understanding how living things are related.

**Q343. What are genes and where are they found?**
**Answer:** Genes are short sections of DNA that contain instructions for making proteins. Proteins control most of the functions in cells and determine traits. Genes are found on chromosomes, which are located inside the nucleus of cells. Each gene has a specific role, such as determining eye colour or controlling how tall a person grows.

**Q344. How did the combination of Mendel's work and chromosome studies lead to modern genetics?**
**Answer:** Mendel's ideas explained how traits are inherited, but he didn't know about chromosomes or DNA. When scientists later discovered chromosomes and saw that they behave like Mendel's "factors," they realised these were genes. This connection formed the basis of modern genetics, combining ideas about inheritance with knowledge of DNA and cell division.

**Q345. How do modern scientists use knowledge of DNA to study inheritance?**
**Answer:** Modern scientists use DNA to study inheritance by analysing genes to see how they cause traits or diseases. They can track inherited conditions in families, study how traits are passed on, and even edit genes using new tools like CRISPR. DNA testing is also used in forensic science, medicine, and understanding evolutionary relationships.

**Q346. Why was the discovery of DNA seen as a major step in understanding genetics?**
**Answer:** The discovery of DNA showed exactly how genetic information is stored and passed from parents to offspring. It explained how genes work and how mutations happen. This helped scientists understand diseases, develop treatments, and study the differences between species. It was a huge step in making genetics a real and practical science.

**Q347. What did Mendel discover about dominant and recessive traits?**
**Answer:** Mendel discovered that some traits are dominant, meaning they are seen even if only one copy is inherited, while others are recessive and only appear if both copies are present. For example, in pea plants, purple flowers are dominant over white. This showed that traits don't just blend but follow specific patterns of inheritance.

**Q348. How did the discovery of DNA help explain how characteristics are passed on?**
**Answer:** The discovery of DNA helped explain that characteristics are passed on through genes made of DNA. Each parent gives one copy of each gene to their child. DNA carries instructions for building proteins, which control how our body works and how we look. This explained how traits are inherited and why some are dominant or recessive.

**Q349. What is the importance of using evidence in developing scientific theories?**
**Answer:** Using evidence is important because it helps scientists make sure their ideas are correct and can be trusted. Evidence supports a theory and shows that it matches what we observe in the real world. Without evidence, ideas are just guesses. Strong scientific theories are based on experiments, data, and repeated testing.

**Q350. Why is it important to understand the history of genetics and evolution?**
**Answer:** Understanding the history of genetics and evolution helps us see how scientific ideas develop over time. It shows how early ideas, like Mendel's, led to modern discoveries. It also helps students understand why we believe what we do today and how new evidence can change our understanding. It makes science more meaningful and accurate.

**Q351. What are fossils and where are they usually found?**
**Answer:** Fossils are the preserved remains or traces of ancient organisms. They are usually found in sedimentary rocks, which are formed from layers of mud and sand over millions of years. These rocks are often found in riverbeds, cliffs, deserts, and underground. Fossils give us clues about animals and plants that lived long ago and help scientists understand the history of life on Earth.

**Q352. How do fossils provide evidence for the theory of evolution?**
**Answer:** Fossils show us how living things have changed over time. By comparing older fossils found in deeper layers of rock to more recent ones, scientists can see how species have evolved. Fossils can reveal changes in structure, appearance, or size, supporting the idea that life forms have developed gradually through natural selection and adaptation.

**Q353. Describe how fossils can form when conditions for decay are not present.**
**Answer:** Fossils can form when an organism dies in a place where decay doesn't happen, such as in very cold, dry, or oxygen-free environments. In these conditions, bacteria and fungi that usually break down dead things can't survive, so the soft tissues of the organism may be preserved. This can lead to whole organisms being fossilised with details like skin or fur still intact.

**Q354. How can parts of organisms turn into fossils through mineral replacement?**
**Answer:** When an organism is buried in sediment, water rich in minerals can seep into its bones or hard parts. Over time, the original material is replaced with minerals like silica or calcite. This process keeps the shape of the original body part but turns it into rock. This is one of the most common ways fossils of bones, shells, and teeth are formed.

**Q355. What are trace fossils and how are they formed?**
**Answer:** Trace fossils are not parts of the organism's body but signs of its activity, like footprints, burrows, or droppings. They form when an animal leaves a mark in soft ground like mud or sand. If this area is quickly covered by more sediment, the shape can be preserved and harden over time into rock, giving clues about how the animal lived and moved.

**Q356. Why is the fossil record incomplete?**
**Answer:** The fossil record is incomplete because not all organisms become fossils when they die. Most decay completely or are eaten. Fossilisation needs specific conditions that don't always happen. Also, many fossils haven't been found yet or have been destroyed by natural forces like erosion or earthquakes. This makes it hard to know the full history of life.

**Q357. Why is it difficult to know exactly how life began on Earth?**
**Answer:** It's difficult to know exactly how life began because the first life forms were soft-bodied and didn't

leave fossils. Any remains may have been destroyed by geological activity over billions of years. Also, conditions on early Earth were very different, and we can only make educated guesses based on limited evidence and experiments that try to recreate those conditions.

**Q358. How can scientists use fossils to study how organisms have changed over time?**
**Answer:** Scientists use fossils by comparing the features of organisms from different time periods. This shows how certain traits developed or disappeared. For example, they can see how fish evolved into land animals by looking at fossils with features in between. By arranging fossils in age order, scientists build a timeline that shows the gradual changes in species.

**Q359. What are some reasons why early life forms did not leave fossils behind?**
**Answer:** Early life forms were simple and soft-bodied, so they decayed quickly after death. They also lived in conditions where fossilisation was unlikely, like shallow seas or hot environments. Geological activity may have destroyed any traces that did form. As a result, we have very little fossil evidence from the earliest periods of life on Earth.

**Q360. What can evolutionary trees tell us about extinct species?**
**Answer:** Evolutionary trees, also called phylogenetic trees, show how different species are related through common ancestors. They include extinct species based on fossil evidence and help us see how those species connect to modern ones. The branches show how groups split over time, giving a visual guide to the path of evolution and when extinctions happened.

**Q361. How is data from fossils used to construct evolutionary trees?**
**Answer:** Scientists look at the physical features of fossils and compare them to modern organisms. They examine things like bone shape, structure, and age of the fossils. DNA from living species is also used to match traits. By combining this information, they can estimate how closely related species are and build evolutionary trees that show these relationships.

**Q362. How do evolutionary trees show the relationships between species?**
**Answer:** Evolutionary trees show how species have evolved from common ancestors. The base of the tree is the oldest ancestor, and branches represent groups of species that evolved later. The closer two species are on the tree, the more closely related they are. These trees help scientists see patterns of evolution and how traits have changed over time.

**Q363. What is extinction?**
**Answer:** Extinction is when all individuals of a species die out and the species no longer exists. Once extinct, the species cannot come back naturally. Extinction can happen for many reasons, such as environmental changes, disease, new predators, or lack of food. It is a normal part of evolution, but human activities have made some extinctions happen faster.

**Q364. Give two possible causes of extinction.**
**Answer:** Two possible causes of extinction are: (1) Environmental changes like climate change or natural disasters, which can destroy habitats, and (2) Introduction of new predators or diseases, which the species

cannot defend against. These changes make it hard for the species to survive, leading to fewer individuals and eventually extinction.

**Q365. How can environmental changes lead to extinction?**
**Answer:** Environmental changes like floods, droughts, temperature shifts, or loss of habitat can make it hard for organisms to survive. If a species cannot adapt quickly enough or move to a new area, it may not find food or shelter. This can reduce population size over time until the species eventually dies out and becomes extinct.

**Q366. What role do new predators play in extinction?**
**Answer:** New predators can hunt a species that is not adapted to defend itself. If the prey species cannot escape or protect itself, many individuals will be killed. Over time, the population may fall too low to recover. This can especially happen when predators are introduced by humans to new areas, leading to extinction of native species.

**Q367. How can the introduction of new diseases contribute to extinction?**
**Answer:** When a new disease spreads in a population that has no natural immunity, it can kill many individuals quickly. If the disease spreads widely and affects all age groups, the population may not recover. This is especially dangerous in small populations, where losing even a few individuals can lead to extinction.

**Q368. How might competition for resources cause a species to become extinct?**
**Answer:** If two species compete for the same food, space, or other resources, the one better adapted to get those resources will survive. The weaker species may struggle to find enough to live and reproduce. Over time, its numbers can drop until it becomes extinct, especially if conditions continue to favour the stronger competitor.

**Q369. What effect can catastrophic events like volcanic eruptions have on species survival?**
**Answer:** Catastrophic events like volcanic eruptions can destroy large areas of habitat quickly. They may block sunlight, cause temperature drops, or release toxic gases. These changes can kill plants and animals directly or make it impossible for them to find food and shelter. Whole ecosystems can collapse, leading to extinction of many species.

**Q370. Why are some species more vulnerable to extinction than others?**
**Answer:** Some species are more vulnerable because they have small populations, limited habitats, or special needs. If they rely on a certain food or climate, they are more affected by change. Species with low genetic diversity also struggle to adapt. These factors make it harder for them to survive environmental changes or threats.

**Q371. How can humans contribute to the extinction of species?**
**Answer:** Humans cause extinction by destroying habitats (e.g., deforestation), overhunting, pollution, introducing new predators or diseases, and causing climate change. These actions put stress on species and reduce their ability to survive. For example, cutting down forests can remove the homes and food of many animals, leading to their extinction.

**Q372. Why is extinction an important part of the process of evolution?**
**Answer:** Extinction clears the way for new species to evolve. When one species dies out, it leaves space and resources for others. Natural selection continues, and species better suited to the new environment can survive and grow. This constant change helps life adapt over time and keeps the variety of living things evolving.

**Q373. Why can bacteria evolve quickly?**
**Answer:** Bacteria evolve quickly because they reproduce very fast and in large numbers. They can also exchange genes with other bacteria. This means mutations that help them survive can spread through the population quickly. This fast evolution allows them to adapt to new environments or become resistant to antibiotics in a short time.

**Q374. What happens when a mutation gives bacteria resistance to antibiotics?**
**Answer:** If a mutation makes a bacterium resistant to antibiotics, it can survive treatment while others die. The resistant bacteria continue to multiply, passing on the resistance gene. Soon, most of the bacteria in that population may be resistant. This makes it harder to treat infections and can lead to serious health problems.

**Q375. How does natural selection explain the spread of antibiotic-resistant bacteria?**
**Answer:** Natural selection explains it like this: when antibiotics are used, bacteria that are not resistant die, but any that have a mutation for resistance survive. These resistant bacteria reproduce and spread. Over time, the population changes so that most bacteria are resistant. This shows how natural selection favours traits that help survival.

**Q376. What is MRSA and why is it a concern in medicine?**
**Answer:** MRSA stands for Methicillin-Resistant Staphylococcus Aureus. It is a type of bacteria that has become resistant to many antibiotics, including methicillin. This makes it hard to treat using standard medicines. MRSA can cause serious infections in wounds or the bloodstream, especially in hospitals where people are already weak or ill. Its resistance to treatment makes it a major concern for doctors and healthcare systems.

**Q377. Why should doctors avoid prescribing antibiotics for viral infections?**
**Answer:** Antibiotics only kill bacteria, not viruses. If doctors give antibiotics for viral illnesses like colds or the flu, they won't help the patient and may harm useful bacteria in the body. Over time, this can lead to antibiotic resistance, where bacteria become harder to treat. Avoiding unnecessary use helps keep antibiotics effective when they are truly needed.

**Q378. Why is it important for patients to finish their full course of antibiotics?**
**Answer:** If patients stop taking antibiotics too early, some bacteria may survive and become resistant. These resistant bacteria can multiply and spread to others. Completing the full course makes sure all bacteria are killed, even the tougher ones. This helps stop the infection and reduces the risk of resistance developing and spreading in the population.

**Q379. How can overuse of antibiotics in farming lead to resistant bacteria?**
**Answer:** In farming, antibiotics are sometimes given to animals to prevent disease or help them grow. Over

time, bacteria in these animals can become resistant. These resistant bacteria can spread to humans through food, water, or contact with animals. This means that some infections in people may become harder to treat with normal antibiotics.

**Q380. What are the challenges in developing new antibiotics?**
**Answer:** It is difficult and expensive to create new antibiotics. The process takes many years and may fail in testing stages. Also, bacteria can quickly become resistant to new drugs. Because of this, drug companies may not invest much in antibiotics. At the same time, more resistant bacteria are spreading, so there is a growing need for new treatments.

**Q381. Why might the development of new antibiotics not keep up with resistant strains?**
**Answer:** Bacteria evolve and adapt quickly, often faster than scientists can create new antibiotics. Making a new antibiotic is a slow, costly process. If bacteria become resistant before the new medicine is widely available, it may no longer work. This means that resistant bacteria could spread faster than our ability to fight them with new drugs.

**Q382. How can hospitals reduce the spread of antibiotic-resistant bacteria?**
**Answer:** Hospitals can reduce the spread by following strict hygiene rules, like regular handwashing and cleaning surfaces. Patients with resistant infections can be isolated to stop spreading germs. Staff should only use antibiotics when necessary and follow correct procedures. Good infection control helps protect patients and stops resistant bacteria from spreading.

**Q383. How does antibiotic resistance support the theory of evolution?**
**Answer:** Antibiotic resistance is an example of natural selection. When antibiotics are used, bacteria with resistance genes survive and reproduce, while others die. Over time, more of the population becomes resistant. This shows how small changes (mutations) in organisms can lead to new traits that help them survive, which is the basis of evolution.

**Q384. What is classification and why is it useful in biology?**
**Answer:** Classification is the process of grouping organisms based on their features and relationships. It helps scientists organise and understand the vast number of living things. By knowing how organisms are related, we can predict their characteristics and study evolution. It also helps in identifying species and understanding biodiversity.

**Q385. Who developed the traditional classification system and what were its main levels?**
**Answer:** Carl Linnaeus developed the traditional classification system in the 1700s. He grouped organisms into categories based on their shared features. The main levels, from broadest to narrowest, are: Kingdom, Phylum, Class, Order, Family, Genus, and Species. This system helps organise life in a clear and structured way.

**Q386. What is the binomial naming system?**
**Answer:** The binomial naming system gives every species a two-part Latin name. The first part is the genus, and the second is the species. For example, humans are called *Homo sapiens*. This system helps scientists

all over the world communicate clearly and avoid confusion, since common names can differ between places and languages.

**Q387. How do improvements in microscopes help scientists classify organisms better?**
**Answer:** Better microscopes allow scientists to see tiny structures inside cells more clearly. This helps them notice details that show how organisms are related. For example, they can see cell walls, nuclei, or shapes of bacteria. These discoveries help scientists group organisms more accurately and understand their similarities and differences.

**Q388. How has knowledge of biochemical processes changed classification systems?**
**Answer:** As scientists learned more about DNA, proteins, and cell chemistry, they found new ways to compare organisms. This showed that some organisms that looked alike were not closely related, and others that looked different were related. This led to changes in classification systems to better reflect true genetic relationships.

**Q389. What is the three-domain system and who proposed it?**
**Answer:** The three-domain system is a modern classification method proposed by Carl Woese. It divides living things into three broad groups: Archaea, Bacteria, and Eukaryota. This system is based on differences in cell structure and genetic material. It gives a clearer picture of how life evolved, especially for microscopic organisms.

**Q390. What types of organisms are found in the Archaea domain?**
**Answer:** The Archaea domain includes single-celled organisms that often live in extreme environments, like hot springs, salt lakes, or deep-sea vents. They look similar to bacteria but have very different genetics and cell structures. Archaea are unique because they can survive in places where most life cannot.

**Q391. How is Bacteria different from Archaea in the three-domain system?**
**Answer:** Both Bacteria and Archaea are single-celled, but their cell structures and genetics are different. Bacteria have a different kind of cell wall and simpler DNA. Archaea have features more like Eukaryotes, even though they are small. They also live in extreme places, while Bacteria are found almost everywhere, including on and inside the human body.

**Q392. Which organisms are included in the Eukaryota domain?**
**Answer:** The Eukaryota domain includes all organisms with complex cells that have a nucleus. This includes animals, plants, fungi, and protists. These organisms can be single-celled or multicellular. Their cells have other structures like mitochondria and often form tissues and organs, making them more advanced than Bacteria and Archaea.

**Q393. What is the main difference between the traditional system and the three-domain system?**
**Answer:** The main difference is that the traditional system grouped all simple organisms as one category, while the three-domain system separates them based on genetics and cell structures. The three-domain system gives Archaea their own group because they are very different from Bacteria. It reflects a more accurate understanding of life's origins.

**Q394. Why is chemical analysis important in modern classification?**
**Answer:** Chemical analysis allows scientists to study the DNA, proteins, and other molecules inside organisms. These tests show how closely related organisms are, even if they look very different. It helps create more accurate classification systems based on true evolutionary relationships, not just physical features.

**Q395. What are evolutionary trees used for?**
**Answer:** Evolutionary trees are diagrams that show how species are related and have evolved from common ancestors. They help scientists understand which species are closely related and how traits have changed over time. They also show the order in which species split and help trace the history of life on Earth.

**Q396. What kind of data do scientists use to build evolutionary trees?**
**Answer:** Scientists use data like fossils, DNA sequences, and physical features to build evolutionary trees. They compare similarities and differences in these features to find out how species are related. The more closely the features match, the more closely related the species are thought to be.

**Q397. How do evolutionary trees help show common ancestors?**
**Answer:** In an evolutionary tree, each branch point represents a common ancestor shared by the species that come from it. By looking at where the branches split, scientists can see which species share a recent ancestor and how long ago they might have separated. This helps trace back the evolutionary history of different groups.

**Q398. How can scientists use evolutionary trees to study extinct species?**
**Answer:** Scientists can place extinct species on evolutionary trees by comparing their fossils to living organisms. Features like bone structure or DNA from preserved remains help show where the extinct species fits in. This helps scientists understand when it lived, what it was related to, and how it contributed to evolution.

**Q399. Why do classification systems change over time?**
**Answer:** Classification systems change as new information is discovered. Improved technology like DNA analysis and better microscopes give scientists more accurate data. Sometimes, new species are found, or old ideas are proven wrong. As a result, systems are updated to show true relationships between organisms more clearly.

**Q400. How does the study of DNA support modern classification systems?**
**Answer:** DNA study shows how closely related organisms are by comparing their genetic code. Organisms with more similar DNA are more closely related. This helps scientists build accurate classification systems based on genetic relationships, not just physical features. DNA evidence has led to the reclassification of many species and the creation of the three-domain system.