Genetics
ANSWERS

Cells and DNA

What is a Cell?
STOP AND CHECK (PAGE 7)

- DNA provides cells with 'instructions' regarding the traits of an individual. It is also responsible for passing genetic information down to future generations.

Structure of DNA
STOP AND CHECK (PAGE 11)

- DNA is made up of two long strands of sugars and phosphates. These strands are twisted together and connected by specific sequences of bases. The bases are bound to each other in accordance with the base pairing rules. The overall structure is called a double helix.
- A DNA molecule is made up of sugar, phosphates and bases.
- According to base-pairing rules, the base 'A' binds to 'T', and 'C' binds to 'G'

Genes and Alleles
STOP AND CHECK (PAGE 13)

- A chromosome is made up of a large amount of DNA wound tightly around itself. In a human, the unique DNA of a cell is split between 23 chromosomes.
- A gene is the name for the general area of DNA coding for a specific trait. For example, there is a specific area on the DNA coding for the eye colour gene.

- Whilst a gene is the name for the general location on the DNA, an allele is the version of the gene that is coded for by a specific series of bases. For example, whilst eye colour is a gene, blue eyes may be an allele.

Genotype and Phenotype

STOP AND CHECK (PAGE 16)

- The genotype shows the alleles present in an individual for a specific gene. It is expressed using letters (i.e. Gg). The phenotype describes the physical result of the genotype. It is expressed in words (i.e. green eyes).
- Dominant alleles are always physically expressed when they are present in a genotype. Recessive alleles can be 'masked' by dominant alleles, so are only expressed when the genotype does not contain any more dominant alleles.

Cells and DNA

QUICK QUESTIONS (PAGE 16)

- The function of DNA is to give instructions to the cell regarding the expression of unique physical traits. It is also to allow these instructions to be passed along to future generations.
- DNA is made up of two long strands of sugars and phosphates. These strands are twisted together and connected by specific sequences of bases. The bases are bound to each other in accordance with the base-pairing rules. The overall structure is called a double helix.
- A gene is the name for the general location on the DNA, responsible for the coding of a specific trait. An allele is the version of the gene that is coded for by a specific series of bases.
- The genotype is the combination of alleles present at a certain gene. It describes the alleles passed on from each parent (in a human this is one from the mother and one from the father). The phenotype is the physical result of the genotype. It is determined by the combination of alleles and their respective dominance.

Introducing Mutations

Introducing Mutations

STOP AND CHECK (PAGE 17)

- A mutation is a random, irreversible change to the DNA base sequence of an individual.

Effects of Mutations

STOP AND CHECK (PAGE 19)

- A gamete is a 23 chromosome cell that combines with another 23 chromosome cell during reproduction. In humans, they are sperm and egg cells. They have 23 chromosomes so that they can pair with a second gamete to form a 46 chromosome zygote.
- Meiosis results in a new combination of alleles as fertilisation require a sperm and egg cell to come together. Both of which contain differing alleles for each gene. This is randomised further by the process of independent assortment.

What the Heck is Meiosis?

STOP AND CHECK (PAGE 20)

- Cells divide twice during meiosis (one more time than in mitosis). This is to create final gametes with half the number of chromosomes as a somatic cell.

How Mutations Effect Sex and Non-Sex Cells

QUICK QUESTIONS (PAGE 21)

- A mutation is a permanent change to the DNA sequence of an individual.
- Gametic cells have half the number of chromosomes that somatic cells have. This is important so that gametes can combine to form a zygote.

- During Meiosis, a cell performs one round of DNA replication and two cell divisions in order to form gametes with 23 chromosomes.

Determining Phenotypes and Genotypes

Punnett Squares

STOP AND CHECK (PAGE 24)

- Genotype ratio = 1(BB):1(Bb)
    - Phenotype ratio = 1(all brown eyes)
- Genotype ratio = 1(Hh):1(hh)
    - Phenotype ratio = 1(brown hair):1(blonde hair)
- Genotype ratio = 1(DD):2(Dd):1(dd)
    - Phenotype ratio = 3(tall):1(small)
- The real phenotype ratio doesn't always match the predicted one, as each offspring is treated as its own statistical event. Therefore, the probability of specific traits being present within each new offspring is not affected by the traits of the offspring prior. The smaller the number of offspring, the less likely the real phenotype ratio is to match the predicted one.

Pedigree Charts

STOP AND CHECK (PAGE 26)

- Females are represented by circles; males are represented by squares. Shaded shapes represent an individual affected by the trait you are tracking. Horizontal lines between individuals represent a set of parents who have sexually reproduced. Vertical lines branching off horizontal lines lead to offspring.
- Concepts to help you determine the genotypes of individuals from a pedigree chart:
    - An individual displaying the recessive phenotype must have a homozygous recessive genotype.

- Homozygous recessive offspring can only be produced if both parents have a recessive allele in their genotype.
- An individual with the dominant phenotype may have either the heterozygous or homozygous dominant genotype.
- If an individual with the dominant phenotype produces offspring with the recessive phenotype, it must have the heterozygous genotype.

Determining Phenotypes and Genotype

QUICK QUESTIONS (PAGE 26)

- Punnett squares can be used to determine the genotype and phenotype ratios of offspring by comparing all possible combinations of alleles produced by the parents. The phenotypes and genotypes produced in the square can be counted to produce ratios.
- Pedigree charts can be used to determine the genotype of individuals by combining phenotypic information from the parents and the offspring they produce. By thinking about the alleles required to produce dominant and recessive traits, genotypes can be determined by problem-solving.

Variation

Sexual and Asexual Reproduction

STOP AND CHECK (PAGE 27)

- Sexual reproduction involves combining the alleles from two different parents. This results in offspring which are genetically different from either parent. Asexual reproduction involves the direct replication of the DNA of one parent. This results in offspring which are genetically identical to the parent.
- Genetic variation can be created through reproduction and mutation in sexually reproducing organisms. In asexually reproducing organisms, genetic variation can only be created through mutation.

Population Variation

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- Genetic variation is important in ensuring the survival of the population when the environment changes. For example, it is important to have organisms that are able to defend themselves from different predators, so that, when a new predator is introduced, some of the organisms will survive.
- Natural selection describes the concept of the 'survival of the fittest'. This concept states that organisms with favourable alleles are more likely to survive long enough to reproduce and therefore pass their alleles on to offspring. This means that, over time, favourable alleles become more common in the population.

Variation

QUICK QUESTIONS (PAGE 31)

- Meiosis increases genetic variation, as it results in random combinations of alleles, which differ every time it is performed. This creates genetically unique offspring.
- Sexual reproduction involves combining the alleles from two different parents. This results in offspring which are genetically different from either parent. Asexual reproduction involves the direct replication of the DNA of one parent. This results in offspring which are genetically identical to the parent.
- Sexual reproduction creates genetic variation in a population, as it involves the combination of the alleles from two different parents. The combination of alleles results in offspring which are not identical to either parent. Additionally, the random nature of sexual reproduction results in different allele combinations each time it is performed, resulting in non-identical offspring.
- Genetic variation is important in a population, as it makes the population more likely to be able to respond to a change in their environment. For example, in a population that survives from predators through its ability to camouflage into the trees. If a change in climate caused the colour of the trees to change slightly, there would need to be some individuals within the population able to camouflage with the new tree colour in order to survive and continue the population.