SB3 – Genetics (Paper 1)

SB3a Sexual and Asexual Reproduction

What is the difference between sexual and asexual reproduction?
Sexual reproduction involves fertilisation of a female sex cell by a male sex cell. Asexual reproduction occurs without fertilisation and produces clones.

What is the advantage of sexual reproduction?
Sexual reproduction combines characteristics from both parents. This increases variation.

Give an example of a plant that reproduces asexually.
Many plants reproduce asexually. For example strawberry plants use runners, which are special stems that grow out from the adult plant. Others produce new plants from bits of leaves or roots.

What is the advantage of asexual reproduction? Asexual reproduction is much faster than sexual reproduction because there is no need to find a mate.

C New strawberry plants grow where a runner touches the ground. When the new plant has well-developed roots, the runner dies off and the plant grows on its own.

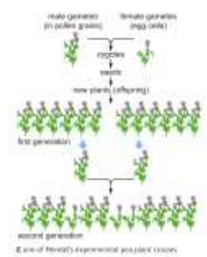
SB3f Mendel

What did Gregor Mendel develop?
Mendel bred (or crossed) pea plants together by using a paint brush to move pollen from one plant to the flower of another plant. A bag was then placed over the flower on the plant and sealed. Mendel planted the seeds that formed and observed the characteristics of the offspring.

What were Mendel's 3 laws of inheritance?

1. Each gamete receive only 1 factor for a characteristic.
2. The version of a factor that a gamete receives is random.
3. Some version of a factor are more powerful than others and always have an effect in offspring.

What did Mendel conclude after his experiments?
Mendel concluded that inherited factors control the variation of characteristics. These factors exist in different versions that do not change. A plant has 2 factors for each characteristic, which are either the same version of 2 different versions. Plants with 2 factors of the same version were true-breeding. This meant that the plant was self-pollenated and the offspring had the same variation as the parent.



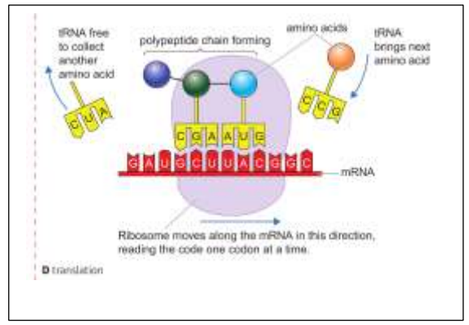
E one of Mendel's experimental pea plant crosses

SB3d Protein Synthesis

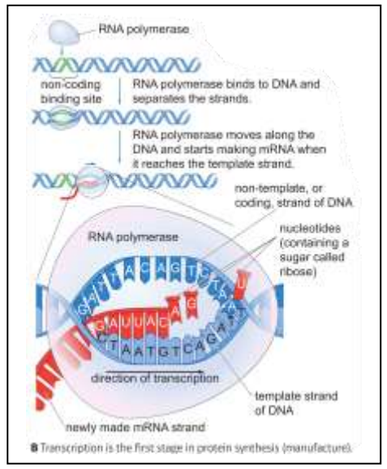
Who worked out the structure of DNA?
James Watson and Francis Crick first worked out the structure of DNA in 1953.

What evidence did they use to make their discovery?

- Erwin Chargaff's chromatography experiments showed that the amounts of A and T in an organisms DNA were the same as the amount of G and C.
- Rosalind Franklin took an X-ray photograph suggesting that DNA was helix.
- Jerry Donohue showed them how DNA bases could form hydrogen bonds.



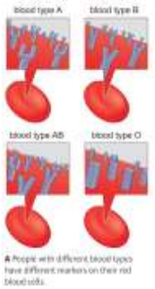
What is translation?
The mRNA strands travel out of the nucleus through small holes in its membrane, called nuclear pores. In the cytoplasm the mRNA strands attach to ribosomes. Then a ribosome moves along an mRNA strand three bases at a time. Each triplet of bases is called codon. At each mRNA codon a molecule of transfer RNA (tRNA) with complimentary bases lines up. Each tRNA molecule carries a specific amino acid. As the ribosome moves along it joins the amino acids from the tRNA together, forming a polypeptide.



B Transcription is the first stage in protein synthesis (manufacture).

SB3i Multiple and Missing Alleles

How do you classify different types of blood?
One way is the ABO blood group system. Everyone's blood group is one of 4 groups: A, B, AB and O. Your blood group is determined by marker molecules on the outside of your red blood cells. There are 3 types of markers, A, B and O.

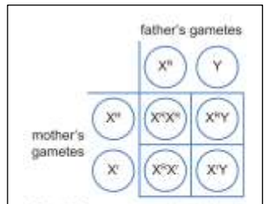


A People with different blood types have different markers on their red blood cells.

What genes is responsible for the markers in the ABO system?
The gene that is responsible has 3 alleles, written as I^A, I^B and I^O. Everyone has 2 copies of the gene so maybe homozygous for any of the 3 alleles or heterozygous for any 2 of the 3 alleles. I^O is recessive to both I^O and I^B however I^A I^B is said to be codominant.

Explain how sex-linked genetic disorders arise?
The human Y sex chromosome is missing some of the genes found on the human X sex chromosome. If the allele for one of these X chromosome genes causes a genetic disorder, then a man will develop that disorder.

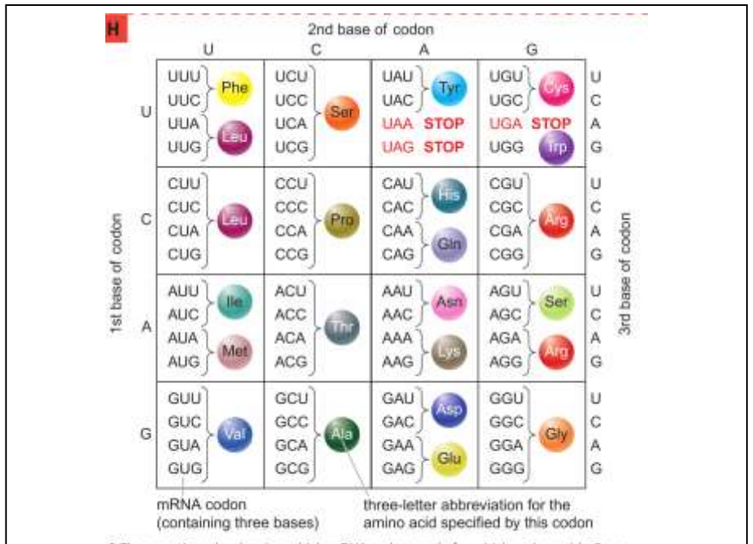
Give an example of a sex-linked genetic disorder.
Red green colour-blindness occurs in about 8% of men but only 0.5% of women.



C In this Punnett square, the allele for colour blindness on the X chromosome is written as X' and the allele for normal colour vision is written as X^n. The Y chromosome does not have an allele for this gene.

SB3e Genetic Variance and Phenotypes

What did Har Gobind Khorana discover?
Khorana cracked the genetic code which matched codons to specific amino acids.



A The genetic code, showing which mRNA codons code for which amino acids. Some codons stop translation.

What is a mutation?
It is a change in the bases of a gene. It can be caused when DNA is not copied properly in cell division. Environmental factors can also cause mutations. Some mutations can change an organisms' phenotype.

How can mutations cause disease?
Mutations are the reasons that genes exist in different forms, called alleles. Haemoglobin contains 4 polypeptides of 2 kinds, α and β. Diagram B shows the mRNA made by the transcription of different alleles of the β-polypeptide genes.

B mRNA from different β-polypeptide alleles

Alleles 1 and 4 in diagram B result in the production in a polypeptide that folds correctly. The polypeptide from allele 2 folds incorrectly and can cause sickle cell disease. Allele 3 also produces and incorrectly folded chain, which can make red blood cells beak apart and cause shortness of breath.

What can cause the mutation β-thalassaemia?
RNA polymerase attaches to DNA bases in front of a gene. A mutation in this non-coding region may result in RNA polymerase not binding well reducing transcription. This mutation causes β-thalassaemia in which not enough β-polypeptide is made for haemoglobin. This causes tiredness, weakness and shortness of breath. This is a non-coding mutation.

Key Vocabulary Definitions

ABO blood group – system of sorting human blood into one of four phenotypes (A, B, AB, O) on the basis of antigens on blood cells.

Codominant – when two alleles for a gens both affect the phenotype, for example a person with the alleles for the A blood group and B blood group have a blood group AB.

Codon – a set of three bases (a triplet) found in DNA and RND the genetic code is formed from patterns of codons.

Complimentary – two DNA bases that fit into each other and link by hydrogen bonds.

Genetic Code – a set of rules defining how the base order in DNA or RNA is turned into a specific sequence of amino acids joined in a polypeptide chain.

Genetic Disorders – a disorder caused by faulty alleles.

mRNA – a single strand of RNA produced in transcription.

Nuclear pore – a small hole in the membrane around the nucleus.

Polypeptide – a chain of amino acids.

Ribosome – a sub-cellular structure that attaches to mRNA. It allows tRNA molecules to match up with the mRNA codons and also joins the amino acids together.

RNA – abbreviation for ribonucleic acid. The molecule is made up of phosphate groups and ribose sugars linked together with one of four bases.

RNA polymerase – an enzyme that creates mRNA from DNA.

Sex linked genetic disorders – a disorder caused by genes that is inherited differently in males and females, such as red-green colour blindness which is more common in men than in women.

Template strand – the strand of a DNA molecule that RNA polymerase uses to make mRNA.

Transcription – the process by which the genetic code in one strand of DNA molecules is used to make mRNA.

Translation – the process by which the genetic code in a molecule of mRNA is used to make a polypeptide.

tRNA – a molecule of RNA that carries an amino acid.

Uracil – a bases found in RNA but not in DNA.

Variations – differences in the characteristics of organisms.