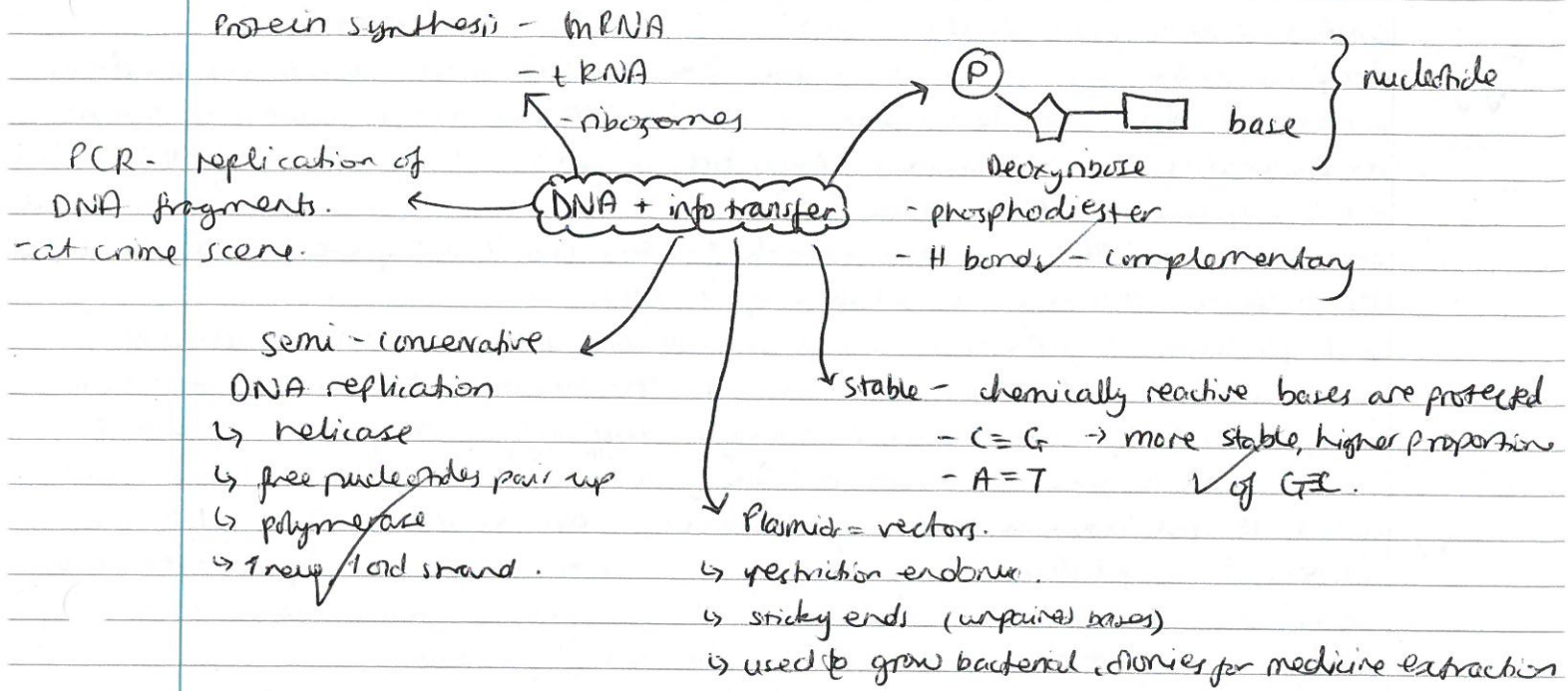
Rebecca. DNA and the transfer of information. 23/5/18




~~DNA is the molecule in eukaryotic and some prokaryotic cells by which hereditary info~~

DNA is a stable molecule formed of two complementary polynucleotide strands, joined by hydrogen bonding between complementary bases. A DNA molecule is a double helix structure as the two complementary strands, which run in opposite directions to each other, are wound into a helix shape. Each nucleotide in a single strand of DNA (a polynucleotide) is composed of a phosphate ion joined to a deoxyribose sugar by a phosphodiester bond, and this pentose sugar is joined by an ester bond to one of ~~the~~ 4 nucleotide bases. These are Adenine, Thymine, cytosine and guanine. A polynucleotide is formed as many nucleotides are joined by phosphodiester bonds in condensation reactions, releasing one molecule of water for each phosphodiester bond

AO1 ✓

The stability of DNA arises from the fact that the chemically reactive bases are on the inside of the molecule and they are protected by the two phosphodiester back-bones. In addition, hydrogen bonding between complementary base pair adds to the stability of DNA. ~~Cyto~~ Adenine forms 2 H-bonds with Thymine, and Cytosine forms 3 H-bonds with Guanine. Therefore, the higher proportion of C-G base pairings a molecule of DNA has, the more stable it is. It is extremely important that DNA is a stable molecule so that the hereditary information it contains can be passed on to new cells in mitosis, and to offspring after gamete production in meiosis, without being altered. ~~The~~ DNA's stability means that mutations are less likely to occur during DNA replication.

AO1 ✓ AO2 ✓

The genetic information that DNA contains is transferred to the next generation of an organism through several stages: DNA replication, meiosis to form gametes, fusion of gametes to form a zygote, mitosis of zygote cell to begin the development of a new organism.

The accepted model for DNA replication is the semi-conservative model. This involves DNA helicase, which breaks hydrogen bonds between the two complementary DNA strands to seperate them. Next, each separated DNA strand acts as a template strand, to which complementary free nucleotides in the nucleus will bond by hydrogen bonding. Then, at this section of DNA, DNA polymerase will attach and form the phosphodiester bonds between nucleotides in order to build up the new DNA strand. In this way, each new DNA molecule contains one of the original polynucleotide strands and one new strand. This means that exactly the same DNA base sequence is maintained during DNA replication, to produce exact copies of the DNA.

In the production of gametes for sexual reproduction, meiosis results in 4 unique daughter cells arising from one cell. The daughter cells are unique due to independent segregation when homologous chromosomes line up at the equator of the cell in metaphase. This means that either of the homologous chromosomes could enter each daughter cell; so the combination of maternal and paternal DNA in a gamete is completely random. Also, when the chromosomes are aligned at the equator, crossing over can occur, which involves the swapping of maternal and paternal alleles, again increasing the variation in gametes.

Finally, during sexual reproduction, the fusion of an egg with a sperm is completely random, meaning that the transfer of genetic information, in the form of DNA, to a new organism is random, too. This genetic variation is important within a population as it makes the population more stable as, in the event of an extreme change in environmental conditions, it is more likely that some individual will posses the necessary alleles that are advantageous to the organism in the altered environment.

AO1 AO2

The transfer of genetic information can also be carried out by scientists in a lab in order to harness useful genes to produce useful chemicals or to introduce into individuals that have a faulty version of that gene (gene therapy). In vivo cloning involves using a restriction endonuclease to cut out the required gene from DNA, by producing a DNA fragment. A restriction enzyme works by cutting DNA at specific restriction sites. This same restriction enzyme is used to cut open a bacterial plasmid, in order to produce complementary 'sticky ends' of unpaired bases on the plasmid and the DNA fragment. The fragment is mixed with the plasmid and DNA ligase is used to form bonds between the plasmid and the fragment. This is called insertion of the required gene. Next, the desired genetic information contained now in the plasmid is inserted into a bacterial cell by heating the plasmids with bacteria and $Ca^{2+}$ ions. The calcium ions and heat make the bacterial cell membrane more permeable, so that the plasmids can be transformed into the bacteria. Gene markers, such as fluorescent marker genes, are used to identify whether the required genetic information has been taken up by the bacterium. Since the gene for fluorescence was cut in order to insert the required gene, any bacteria that have taken up the gene will not fluoresce as their fluorescence gene will be non-functional.

The genetically modified bacteria can be grown on agar nutrients and, the protein produced by the gene, for example the hormone insulin, can be extracted from the bacterial colonies. This is advantageous as it means that transplant of pancreatic

AO1 AO2

tissue is not required in order to treat type 1 diabetes. Instead, the insulin hormone can be injected straight into the patient. Transplantation has risks of rejection, so is not as successful.

AO3. ✓ The gene for vitamin A production can be transferred to rice crops in developing countries, in order to help prevent blindness.

24/25. Fantastic.

Well done.