DNA and RNA continued

Significance of DNA Replication

-Each new DNA double helix will have the exact same sequence of bases as the original.

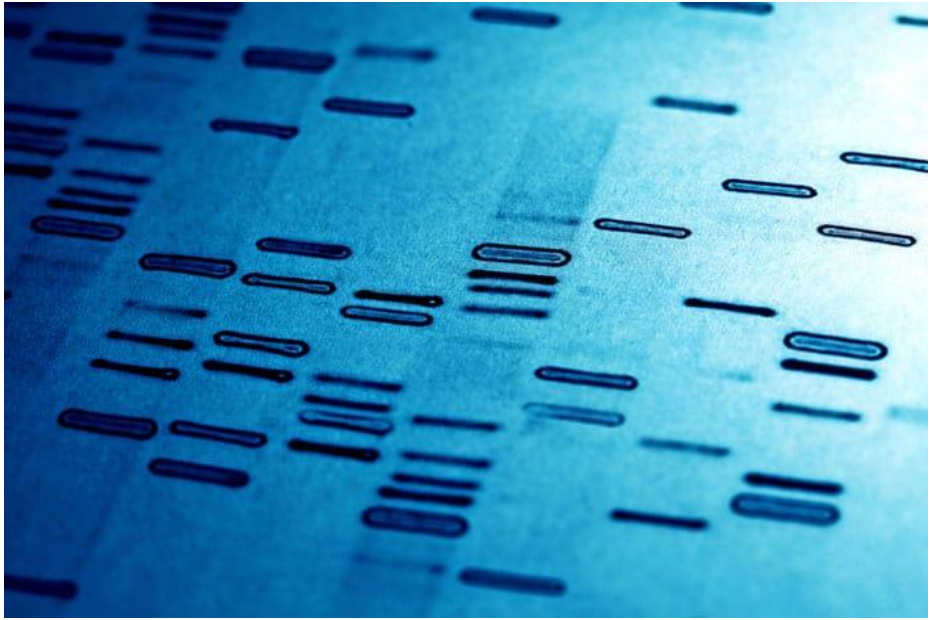
-DNA is able to produce exact copies of itself. This means that the same DNA is passed on to each new generation of cells.

-For example, a human zygote is a single cell with 46 chromosomes.

-These chromosomes contain a certain sequence of bases is passed on, in the form of new chromosomes, to each body cell in a person due to DNA replication.

DNA Profiling

DNA profiling is a method of making a unique pattern of bands from the DNA of a person, which can then be used to distinguish that DNA from other DNA.



DNA Profiling

-Preparing a DNA profile involves 4 steps:

1. *DNA is released:* in order to produce a DNA profile, cells are broken down to release their DNA.
2. *DNA is cut into fragments:* the isolated DNA is cut into fragments using special enzymes. These enzymes are called restriction enzymes and they were first isolated from bacteria where they are used to destroy the DNA of invading viruses. Different restriction enzymes cut DNA at specific base sequences.
3. *The fragments are separated:* the sections of DNA that have been cut out are separated by a process called gel electrophoresis.
4. *Patterns are compared:* if the pattern from the 2 different DNA samples is the same, then the 2 samples must have com from the same person.

Application of DNA profiles

Crime

-Forensic medicine is the way in which medical knowledge is used in legal situations. DNA profiles are often used in forensic cases.

-If biological material such as blood, saliva or hair is left at the crime scene it can be collected and a DNA profile prepared.

Medical

-DNA profiles can be used to determine whether a particular person is, or is not, the parent of a child.

-In this way the paternity or maternity can be established.

Genetic Screening

-Sometimes the process of DNA replication does not work exactly as it should.

-In these cases, a gene may be incorrectly copied. As well as this DNA can be altered by mutations.

-If genes are altered in any way they will not carry the correct code for the protein that they were intended to produce. This may have severe effects on a person who inherits such genes.

Genetic screening means testing DNA for the presence or absence of a particular gene or an altered gene.

Adult Screening

-Screening is sometimes carried out on adults who, although they do not suffer from a genetic disorder, may carry a defective gene in each of their cells.

-People who carry defective genes, without having the disorder, are said to be carriers for that disorder.

-It is now possible to identify individuals who are carriers for disorders such as sickle cell anaemia and the most common form of cystic fibrosis.

RNA (ribonucleic acid)

-DNA and RNA are both nucleic acids.

-RNA also consists of 4 bases, however RNA differs from DNA in the following ways:

-RNA contains the base uracil instead of thymine. So the bases A and U are complementary.

-RNA is a single stranded molecule, unlike DNA, which is double stranded.

-The sequence of bases in RNA is determined by the sequence of bases in DNA. The bases in RNA are complementary to those in a section of DNA.

-RNA can move out of the nucleus into the cytoplasm, whereas DNA is always in the nucleus.

Protein synthesis

1. The sequence of bases on a DNA strand carries instructions in the form of a code to make a particular protein.
2. The bases in DNA and RNA work in groups of three. Each group of 3 bases causes one particular amino acid to become part of the protein being made.
3. The DNA strands separate. This step takes place in the nucleus.
4. RNA bases attach to the exposed bases on one side of the DNA. This means that the code has been transcribed from DNA to a complementary strand of RNA. The RNA strand formed in this way is called messenger RNA (mRNA).

Transcription is the copying of a sequence of genetic bases from DNA onto messenger RNA.

Protein synthesis

5. The mRNA strand detaches from the DNA and moves out of the nucleus.

6. The mRNA passes through a ribosome. As it passes through, each group of 3 bases causes a particular amino acid to be attached to the protein that is made in the ribosome. In this way, the code on the mRNA is translated into the correct sequence of amino acids at a ribosome.

Translation is the conversion of a sequence of genetic bases on mRNA into a sequence of amino acids.

7. The protein becomes folded as it emerges from the ribosome. This allows the protein to carry out its particular function.

Answer qs 7,8,9,10 on page 171 of your book.

Structure of DNA (Higher Level)

-The structure of DNA was worked out by James Watson and Francis Crick in 1953.

-DNA is made up of units called nucleotides and these are arranged into very long chains called polynucleotides.

-The detailed structure of DNA can be considered under 3 headings: nucleotides, base pairs and double helix.

Structure of DNA (Higher Level)

Nucleotides:

-A nucleotide consists of 3 parts: a phosphate group, a sugar and a nitrogen-containing base.

-The sugar in DNA is deoxyribose and RNA contains the sugar ribose.

-The phosphate group is PO4, but this is normally represented as P. The phosphate and deoxyribose groups form the sides of the DNA strand.

-There are 4 nitrogenous bases, 2 classified as purines and 2 a pyrimidines.

-2 purines: adenine and guanine

-2 pyrimidines: thymine and cytosine

Structure of DNA (Higher Level)

Base Pairs:

-Adenine and thymine each form 2 weak hydrogen bonds which allows them to bond together.

-Guanine and cytosine each form 3 hydrogen bonds, so they can pair together.

-The forces holding these bases together are hydrogen bonds, which are weak bonds formed when a slightly positive hydrogen is attracted by another slightly negative atom.

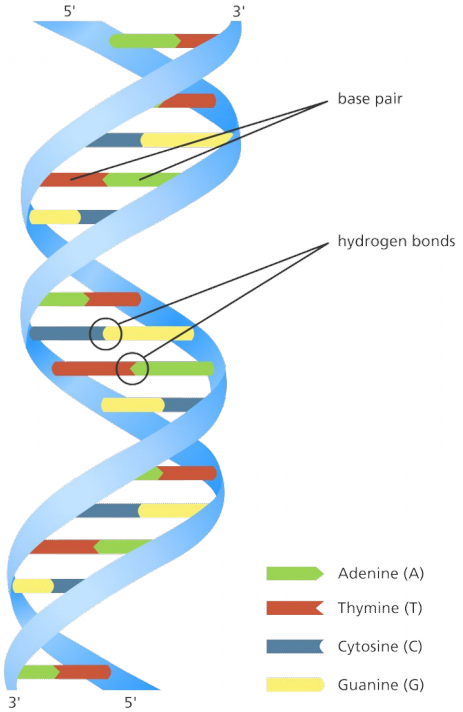
Structure of DNA (Higher Level)

Double helix:

-Crick and Watson discovered that DNA consisted of 2 helical or spiral chains of polynucleotides.

-The outside strand of the double helix are made of deoxyribose and phosphate.

-The ‘rungs’ of the molecule are the base pairs on the inside.



Protein synthesis Higher Level

Initiation:

1. Enzymes in the nucleus start to unwind the DNA double helix at the site of the gene that is going to produce a protein.

Transcription: rewriting the code from DNA to RNA:

2. Complementary RNA bases bond with one of the exposed DNA strands.
3. The enzyme RNA polymerase joins the RNA base together to form mRNA. Each mRNA molecule has complementary bases to those on the DNA strand which it was transcribed. A sequence of 3 bases of DNA or RNA is called a triplet or codon. Each codon will eventually cause one amino acid to become part of the protein being made.

Protein synthesis Higher Level

4. Each mRNA strand carries:

- A start codon
- A series of codons to specify particular amino acids
- A stop codon

Translation-the production of a protein according to the RNA code:

5. mRNA moves from the nucleus to the cytoplasm

6. Ribosomes are made up of ribosomal RNA (rRNA) and protein

7. The mRNA strand forms weak bonds with the rRNA in a ribosome. This will be the site of protein synthesis.

Protein synthesis Higher Level

8. The cytoplasm contains a supply of transfer RNA (tRNA) molecules. Each tRNA carries a special triplet or anticodon and a particular amino acid

9. tRNA molecules are attracted to the mRNA that is in the ribosome. Each anticodon on a tRNA is complementary to a codon on the mRNA. The tRNA molecules enter the ribosome.

10. The first tRNA molecule will attach to the mRNA just after the start codon, by doing this it brings a particular amino acid to the ribosome.

11. The adjacent amino acids are detached from the tRNA and are bonded together by the ribosome to form part of the new protein.

Protein synthesis Higher Level

12. tRNA molecules leave the ribosome without any attached amino acids. By doing this they pull the mRNA strand through the ribosome.

13. tRNA molecules continue to bind with the mRNA until a stop codon is reached. At this point:

- The mRNA code sequence is complete, and
- The new protein is produced.

14. Once the protein is formed it folds to allow it to have the correct shape.

Videos and Questions

Answer qs 11-16

https://www.youtube.com/watch?v=hDV7EhINZww practical

https://www.youtube.com/watch?v=MMG3ABcgmO0

https://www.youtube.com/watch?v=Kr9MtLW6NNg&t=120s

https://www.youtube.com/watch?v=1mB2_XZ4kfk