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Support Pack | Grade 12

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Life Sciences

Life at a molecular, cellular and tissue level

This support pack for the **Life at a molecular, cellular and tissue level** strand in the **Life Sciences Grade 12 CAPS curriculum** provides revision summaries on the topic to help prepare for the examinations. Learners can work through these individually at home or these could form the basis of a catch-up class or online lesson. You have permission to print or photocopy this document or distribute it electronically via email or WhatsApp.

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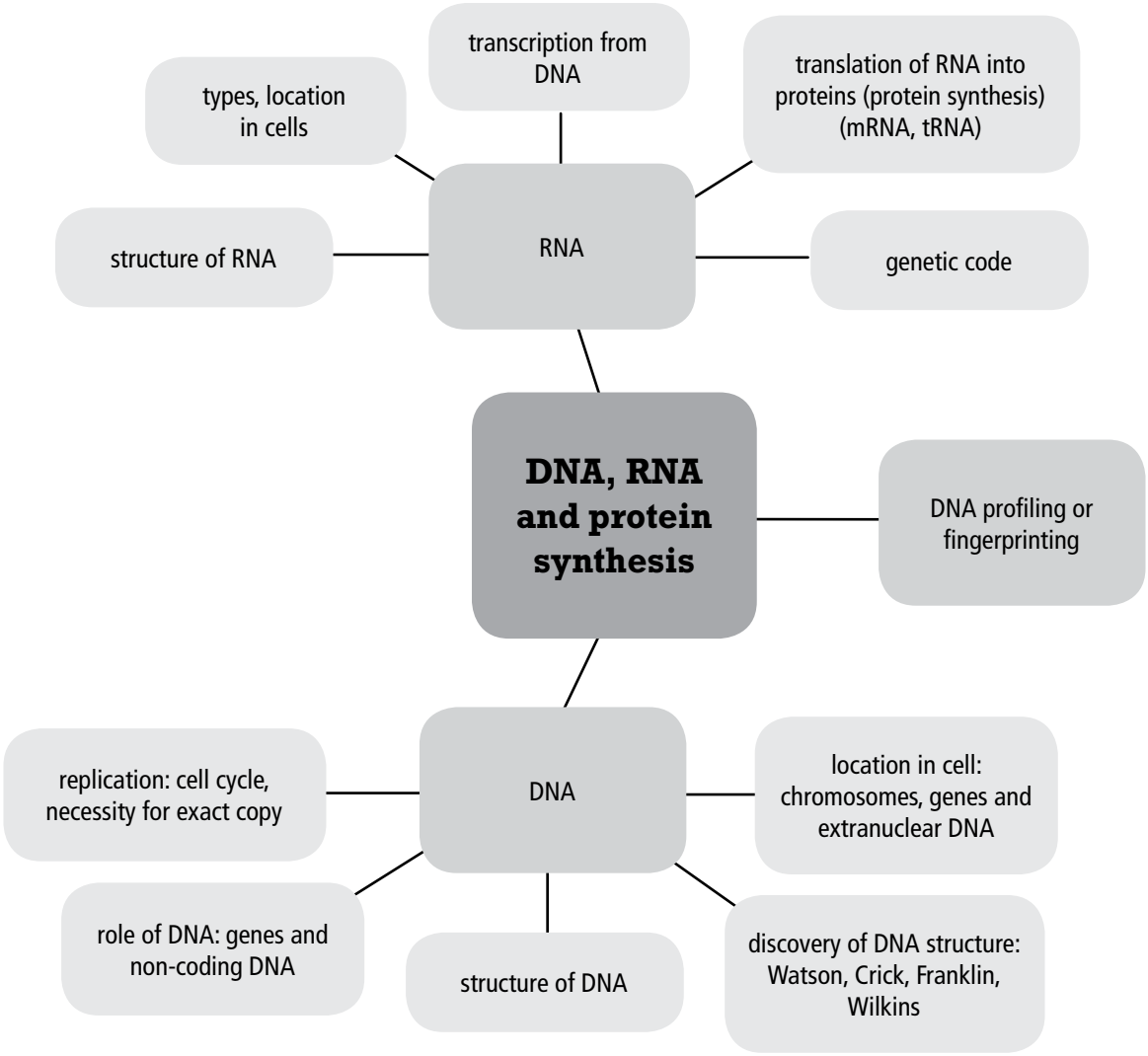
UNIT 1 DNA: The code of life



UNIT 1 DNA: The code of life

DNA

- DNA carries the genetic code for cell specialisation and cell function and genes determine what an organism will look like and how it will function.
- DNA is found in the nucleus of cells in chromosomes, where it forms genes. It is also found outside the nucleus (extranuclear DNA), in the mitochondria (called mitochondrial DNA) and in the chloroplast (called chloroplast DNA).
- DNA was first purified in 1945. Its structure was finally worked out in 1953 by James Watson and Francis Crick, working with Maurice Wilkins and Rosalind Franklin.
- DNA is a double helix that is made up of nitrogen-containing or nitrogenous base pairs.
- DNA is one type of nucleic acid. The other type of nucleic acid that is found in cells is RNA.
- Nucleic acids contain:
    - 5-carbon sugars
    - phosphate groups
    - four types of nitrogen-containing bases.
- Both DNA and RNA are made up of equal portions of these three molecular components. These three molecules are bonded together to form a unit that forms part of the structure of a nucleic acid.
- These units are called nucleotides.
- Each nucleotide that makes up a DNA molecule consists of one of four different nitrogenous bases. These bases are: adenine, guanine, thymine and cytosine.
- Adenine and guanine are called purines and thymine and cytosine are called pyrimidines.
- The amount of adenine present in a DNA molecule is always equal to the amount of thymine, and the amount of guanine is always equal to the amount of cytosine.
- DNA strands are held together by hydrogen bonds between the base pairs.
- Genes are a portion of a DNA molecule.
- Coding DNA specifies enzymes.
- Each gene specifies one polypeptide of a protein.
- Proteins are molecules that may contain one or more different polypeptides.
- Some DNA is non-coding. Non-coding DNA is also called “junk DNA”.
- Non-coding DNA is important in evolution, disease and cell regulation.
- DNA copies itself by a process of replication, which occurs before cell division.
- Replication involves complementary base pairing between new DNA strands.
- The new double-stranded DNA molecules formed during replication are identical to the original DNA molecule.

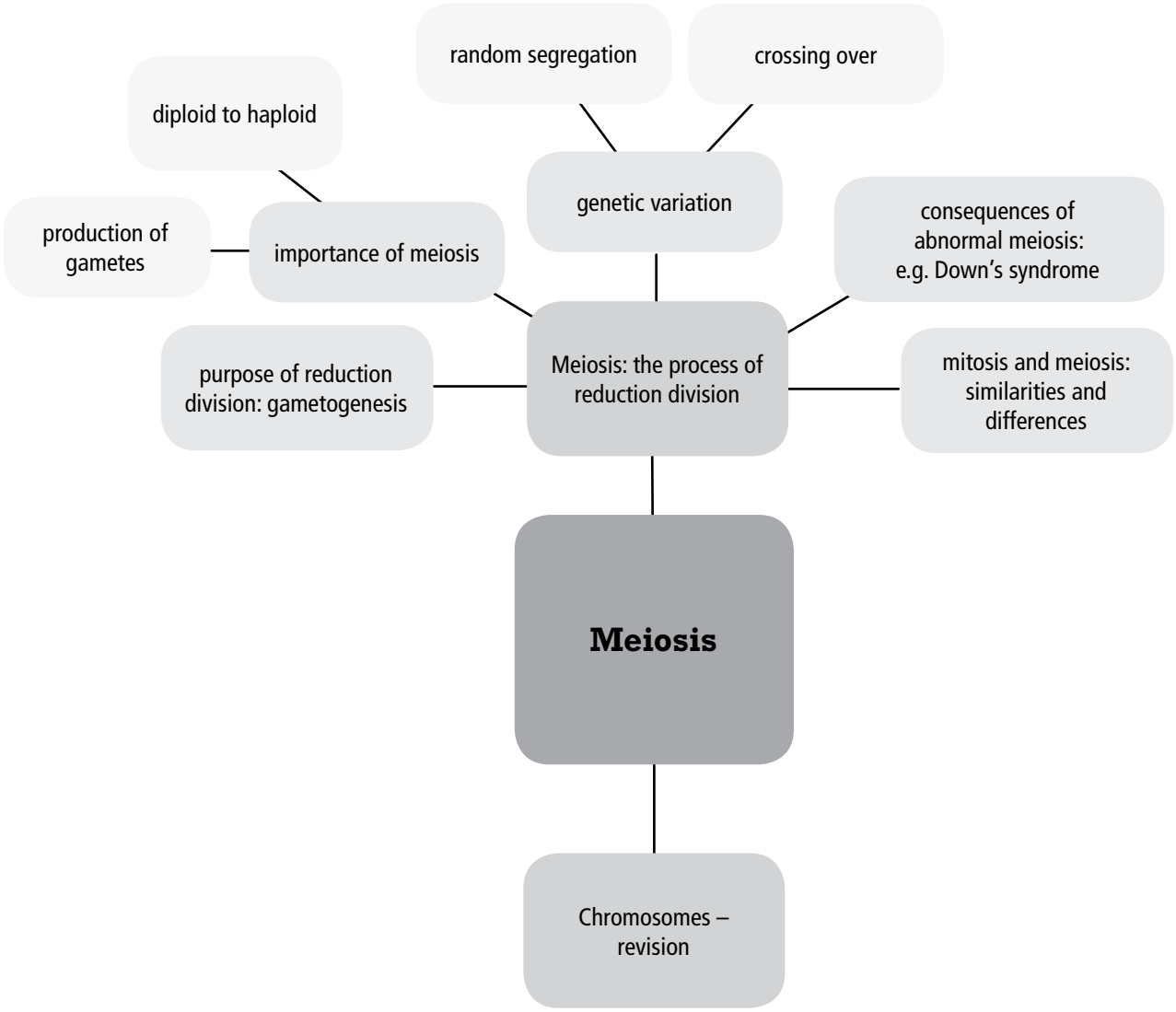
RNA

- RNA is single stranded.
- RNA contains the nitrogenous bases adenine, guanine, cytosine and uracil (instead of thymine).
- There are three types of RNA: messenger RNA (mRNA) found in the nucleus, ribosomal RNA (rRNA) found in the ribosomes and transfer RNA (tRNA) found in the cytoplasm.
- RNA is transcribed from DNA in the nucleus using the DNA as a template. This process is called transcription and depends on complementary base pairing.
- The RNA is transported out of the nucleus into the cytoplasm.
- The process of protein synthesis takes place in the cytoplasm and is called translation.
- During translation, the information on mRNA is converted into a sequence of amino acids, which then form proteins.
- Translation takes place on ribosomes and involves tRNA.
- During translation, mRNA bonds to tRNA using complementary base pairing.
- The genetic code is a sequence of three bases that provide the more than 20 combinations that are needed to code for all the amino acids.

DNA profiling or fingerprinting

- The genetic code is universal – it is exactly the same in all organisms.
- The genetic code can be read as RNA or DNA codons.
- The sequence of nitrogenous bases in RNA and DNA determines the type and order of amino acids in a protein.
- DNA is found in all cells (except red blood corpuscles) and can be found on biological samples at crime scenes.
- This is the basis of DNA profiling or fingerprinting, and non-coding DNA is used in this process.

UNIT 2 Meiosis



UNIT 2 Meiosis

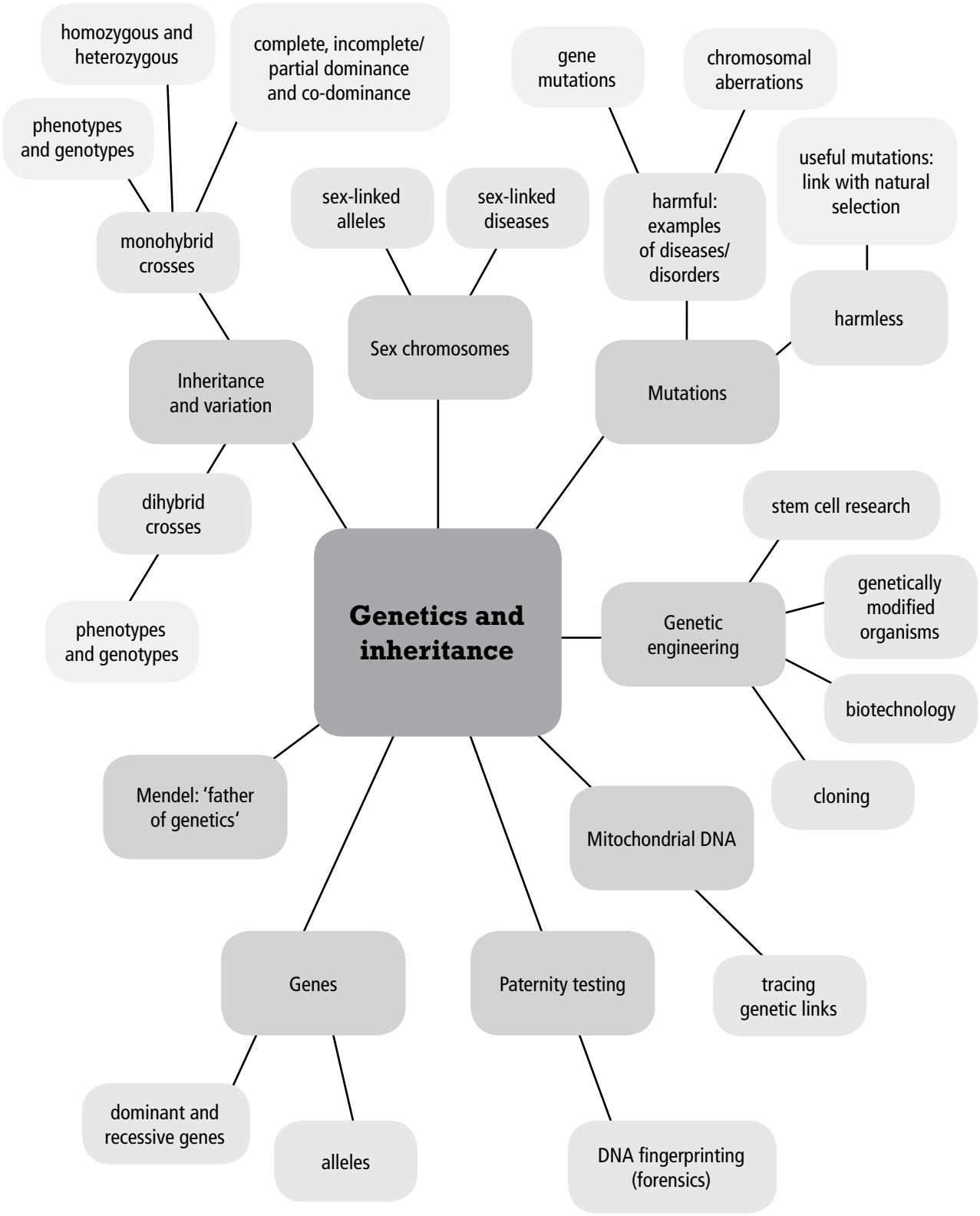
Chromosomes

- Chromosomes are found in the nucleus of cells and carry DNA/genes.
- At nuclear division the chromosome is a double structure and contains two identical DNA molecules.
- Each of the chromatids that makes up a pair of chromatids contains one of the two identical DNA molecules.
- Just before nuclear division, the chromatin coils up, shortens and thickens, forming distinct chromosomes.
- Each chromosome is made up of two chromatids.
- Each pair of chromatids is held together at a point called the centromere.
- Each species has a particular number of chromosomes in the cell.
- Chromosomes occur in homologous pairs.

Meiosis – the process of reduction division

- Meiosis is a process of reduction division that occurs during different stages of the life cycle in different organisms.
- Meiosis only takes place at certain times in the life cycle of a sexually reproducing organism.
- There are two nuclear divisions.
- Meiosis is divided into meiosis I and meiosis II.
- At the end of meiosis II, four haploid (n) daughter cells are formed from the original diploid (2n) cell.
- The four daughter cells have half the number of chromosomes of the parent cells.
- The four daughter cells are not identical to each other or to the parent cell.
- Variation occurs during crossing over and random segregation.
- Abnormal meiosis can produce abnormal numbers of chromosomes, for example in Down's syndrome, where a gamete with an extra chromosome is fertilised by a normal gamete, leading to a zygote with 47 chromosomes instead of the normal 46.

UNIT 3 Genetics and inheritance



UNIT 3 Genetics and inheritance

Genes

- The gene is the molecular unit of heredity in a living organism.
- An allele is one of two or more forms of a gene or group of genes that is located on a specific position on a specific chromosome.
- A dominant allele codes for a dominant characteristic or trait.
- A recessive allele is only expressed or shown when two parents who each have one copy of the recessive gene produce offspring.
- A heterozygous individual carries one dominant and one recessive allele.
- A homozygous individual carries either two dominant (heterozygous dominant) or two recessive alleles (recessive).

Mendel – "the father of genetics"

- Gregor Mendel was an Austrian priest who studied pea plants and formulated the laws of genetics.

Inheritance and variation

- A monohybrid cross is a cross that is made between organisms when scientists are studying the inheritance of one trait or character.
- The phenotype is the outward appearance of an organism.
- The term genotype refers to the alleles that an individual receives at fertilisation.
- In complete dominance the dominant allele masks (blocks) the expression of a recessive allele in the heterozygous condition.
- In incomplete dominance neither allele is completely dominant over the other.
- In co-dominance a cross between organisms with two different phenotypes produces offspring with a third phenotype in which both the parental traits appear together, i.e. both alleles are expressed equally in the phenotype.
- A dihybrid cross is one in which two characteristics or traits are studied.

Sex chromosomes

- Sex chromosomes are the chromosomes that determine the sex of the offspring.
- In humans there is one pair of sex chromosomes: XX in females and XY in men.
- Some diseases and conditions, such as haemophilia and colour blindness, are carried on the X chromosome. They are said to be sex-linked or X-linked diseases and conditions.

Mutations

- Mutations are alterations in the sequence of DNA or alterations in chromosome structure.
- DNA mutations can be point mutations or frameshift mutations.
- Chromosome mutations can be deletions, insertions, inversions and translocations.

Genetic engineering

- Genetic engineering is a field of biotechnology that is used to alter the genome of a living cell for medical, industrial or agricultural purposes.
- Biotechnology involves the identification and use of living organisms and their systems to make products that are useful to humankind.
- Stem cells are cells in the body that are not yet fully differentiated and can be manipulated to produce different tissues.
- Cloning is a biotechnology that is used to produce genetically identical organisms.

Mitochondrial DNA

- Mitochondrial DNA is DNA that is found only in the mitochondria and which can only be passed through the maternal line. It is used to trace genetic lineages.

Paternity testing

- Paternity testing is carried out using blood groups and DNA testing.