

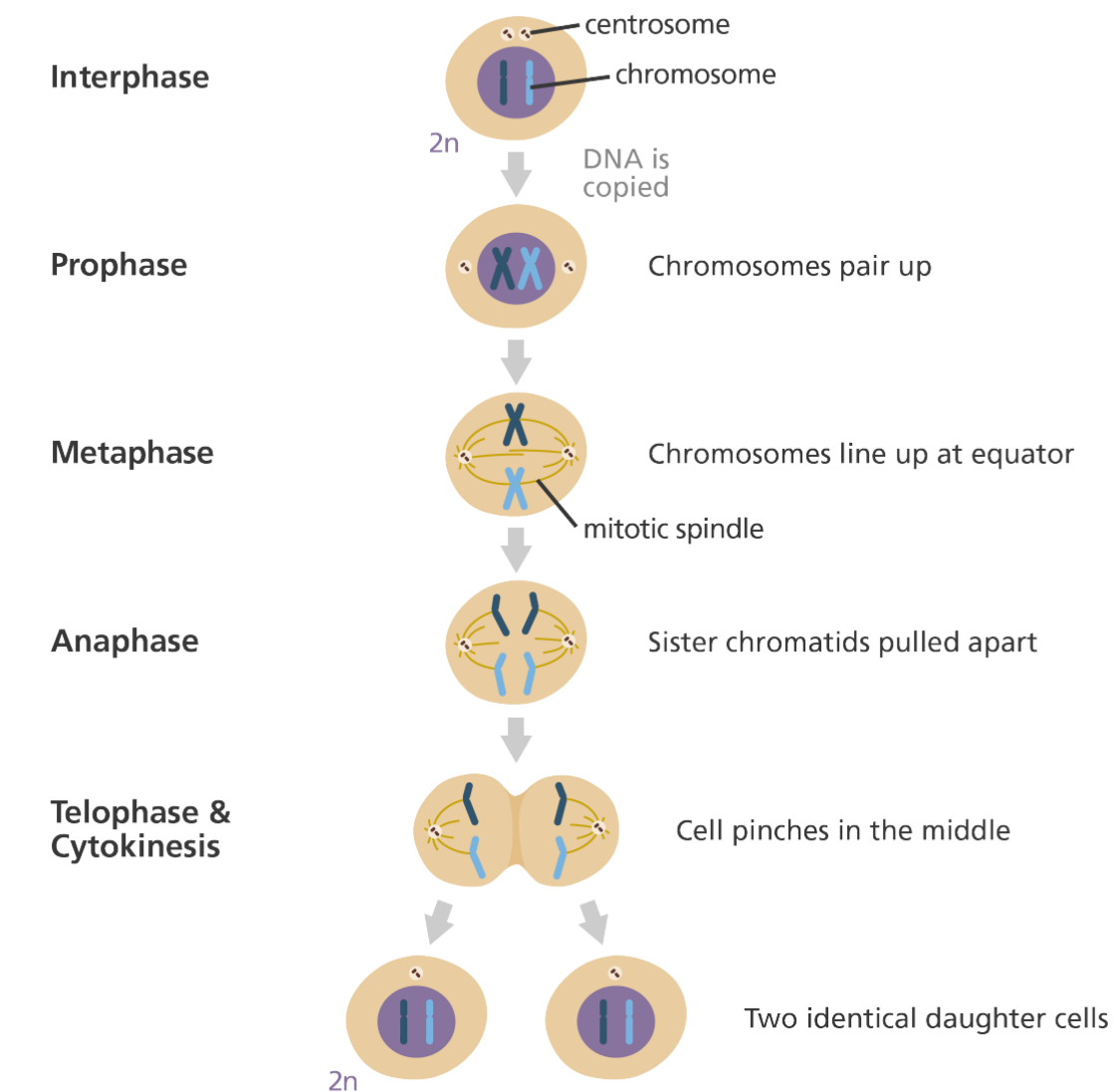
## HSC Biology – Module 5: Heredity – Cell Replication Study Notes

- Cell replication

**Inquiry question: How important is it for genetic material to be replicated exactly?**

- ❖ *model the processes involved in cell replication, including but not limited to:*
  - *mitosis and meiosis (ACSBLO75)*
  - *DNA replication using the Watson and Crick DNA model, including nucleotide composition, pairing and bonding (ACSBLO76, ACSBLO77)*

### Mitosis Model

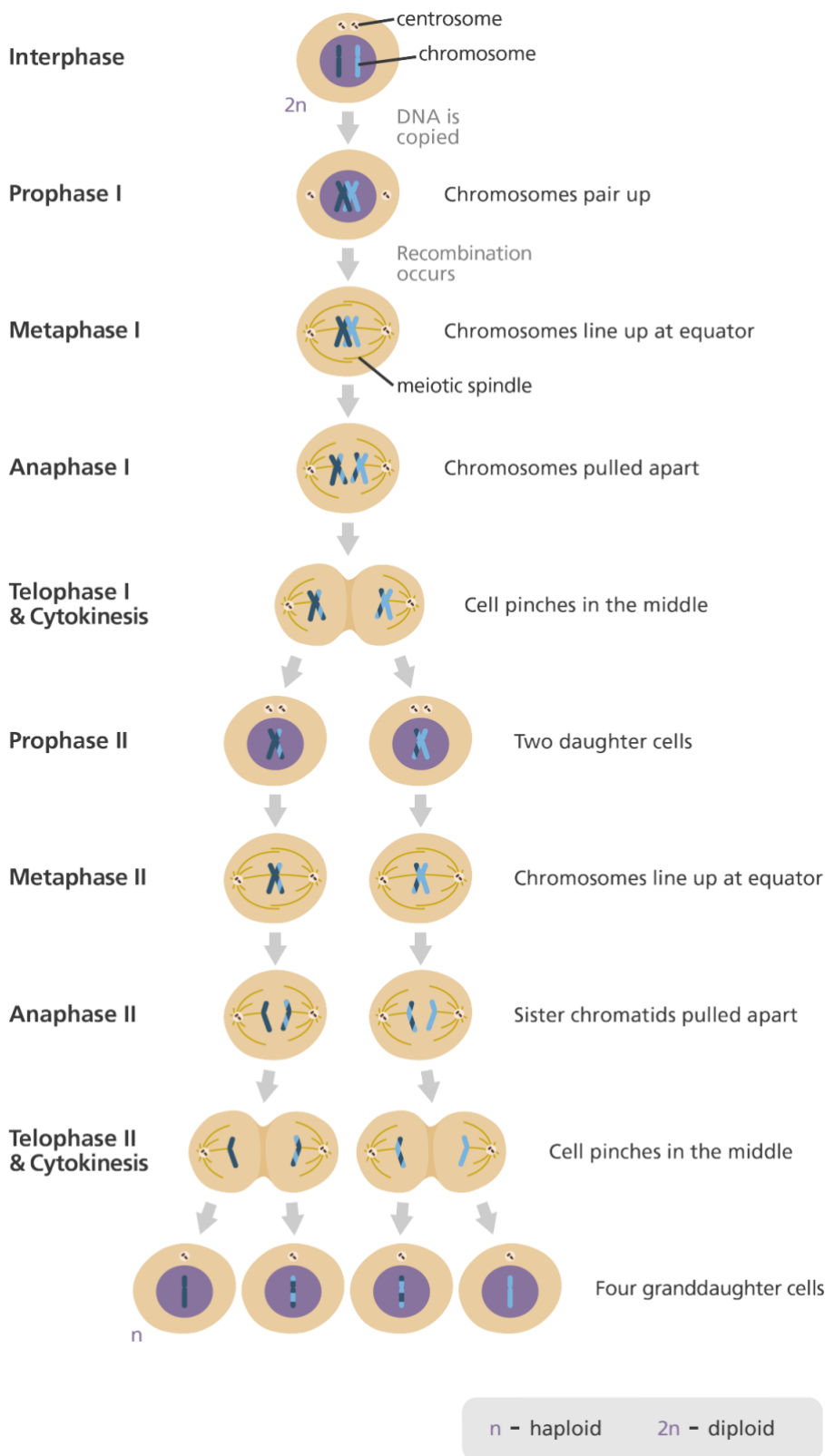


$2n$  - diploid

Image: Genome Research Limited

# HSC Biology – Module 5: Heredity – Cell Replication Study Notes

## Meiosis Model



- Crossing over: segments of chromatids are cut off and exchanged between homologous chromosome pairs to model the exchange of genetic material that occurs in crossing over

- Homologous pairs align in the middle of the cell

- Independent assortment: homologous pairs are separated in the first division. The two unique alignment combinations are modelled to show the effect of independent assortment.

- Original parent cell splits into 2 daughter cells

- Chromatin condenses → chromosomes then align at the equator

- Chromatids move apart to opposite poles

- Random segregation → chromatids randomly pushed to opposite corners

- The 2<sup>nd</sup> meiotic division produces 4 unique daughter cells

Image: Genome Research Limited

### DNA Replication

- Structure of DNA- Watson and Crick model
  - Determined by Watson and Crick in 1953
  - Deoxyribonucleic acid
  - Double stranded helix – made up of sub-units called nucleotides
  - Nucleotide → a monomer of nucleic acids made up of phosphate, deoxyribose sugar and a nitrogenous base (chain = polynucleotide)
  - Four different bases → A (adenine), T (thymine), G (guanine) and C (cytosine)
    - A – T, G – C
  - Base attaches to the sugar
  - Genes are short segments making up chromosomes – like beads on a string
  - Structure allows:
    - Large amounts of information to be stored
    - Replicated in meiosis and mitosis
    - Genetic information to be read in protein synthesis
- Replication of DNA
  - Exact copy must be made so when cells divide, daughter cells have full complement DNA
  - Replicates before cell division so that each cell can receive one full and exact copy
  - Process
    - Enzyme helicase unwinds double helix
    - The two strands separate
      - Weak hydrogen bonds break between complementary bases of the nucleotides on opposite strands, DNA strands separate and expose bases- this ‘unzipping’ is also carried out by enzymes.
    - Free nucleotides (floating in the nucleus) attach to the exposed bases due to the enzyme DNA polymerase, A – T, C – G,
      - Ensure replication is exact – repairing is actually a process of replication
    - Each molecule now contains one strand of existing DNA and a newly-synthesised strand
    - Mutations occur in incorrect base pairing → change in the DNA base sequence

## Watson & Crick DNA Model

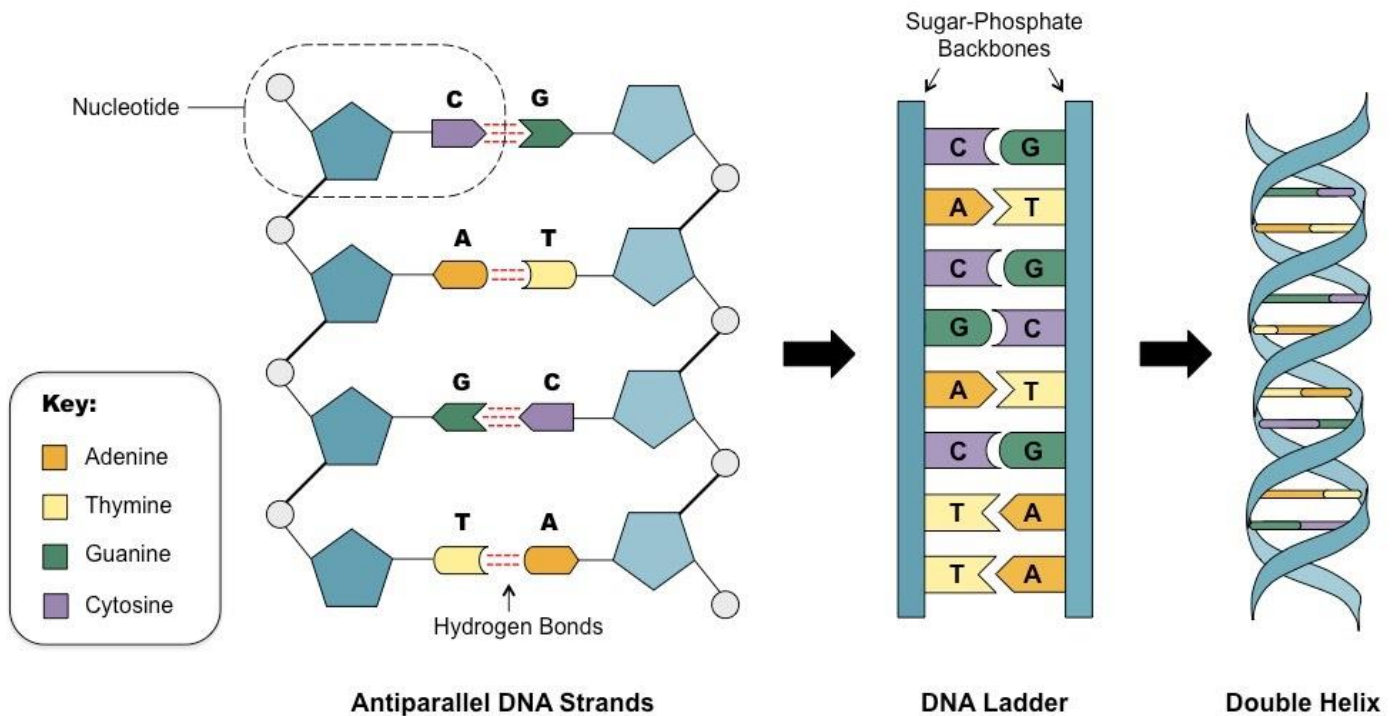


Image: Cornell, B. 2016. *DNA Structure*. [ONLINE] Available at: <http://ib.bioninja.com.au>. [Accessed 2019]

❖ *assess the effect of the cell replication processes on the continuity of species (ACSBLO84)*

### Significance of DNA replication:

- Identical copies of the genes can be made so the daughter cells have the necessary coded instructions that control the basic life functions of the cell
- Heredity - relies on DNA replication
- Growth, repair and maintenance of an organism
- Gene expression - relies on protein synthesis
- Exact copy so replication occurs – mutations may have a direct effect on phenotype
- Mutation- whilst some mutations can be lethal, mutation is the source of new alleles which ultimately leads to variation within a species.

### Significance of Mitosis:

- Enables genetic material to be exactly copied – enzymes produced by genes ensured that DNA is copied correctly
- Allows organisms to grow, maintain and repair body cells → maintaining health & thus allowing continuity of species

### Significance of meiosis:

- Meiosis increases genetic variation within a species through crossing over, independent assortment and random segregation

## HSC Biology – Module 5: Heredity – Cell Replication Study Notes

- Increased variation within a species, means the species has a greater chance of surviving an environmental change, as a specific advantageous trait can be 'selected', and the species can evolve to possess this trait through natural selection, which is not possible without variation.

**Therefore, cell replication processes such as DNA replication, mitosis and meiosis are pivotal and crucial in the continuity of a species.**