TENDER HEART HIGH SCHOOL , SEC - 33B, CHD

CLASS - X BIOLOGY

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13.05.02024

CHAPTER 2 - STRUCTURE OF CHROMOSOME, CELL CYCLE and CELL DIVISION.

This lesson is of Class 10 for the subject of Biology Topic Structure of Chromosome and cell cycle which is covered in Chapter - 2 Structure of chromosome, cell cycle and cell division starting on Page No 8 of your text book titled - Concise Biology Selina Publications

Dear students as you all know that the nucleus of a cell contains genetic material [i.e. the chromosomes / chromatin fibres] which carry the information [hereditary information] from parents to the offsprings. So let us learn the structure of these chromosomes

Chromosome - Nucleus contains the chromosomes. Chromosomes are highly coiled and condensed chromatin fibres Chromatin fibres are a complex made up of DNA molecule associated with many proteins

When a cell is not dividing chromatin appears to be a long thin dark fibre, however, as a cell prepares to divide the chromatin fibre coil and condense further eventually becoming thick enough to be distinguished as separate chromosomes.

Chromosomes readily pick up certain dyes and get coloured, hence the name chromosome.

CHROMAIN - material is formed of two substances

1. DNA - 40%.
2. Histones - 60%.

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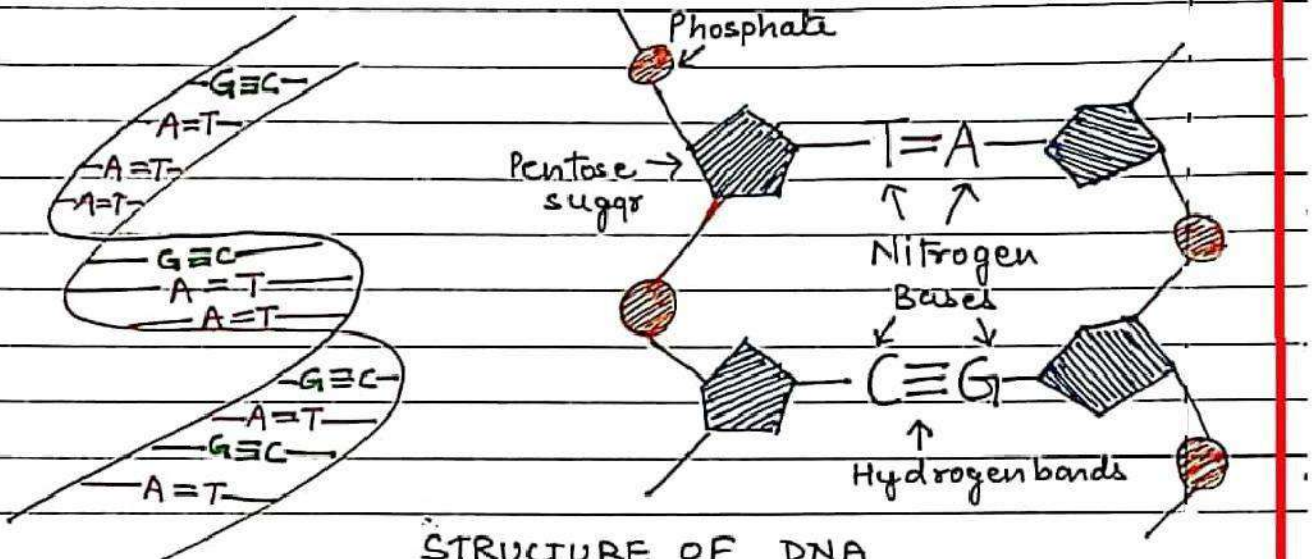
Molecular structure of DNA

Watson and Crick in 1953 proposed the double stranded helical structure of DNA Single DNA molecule is very large hence it is called a macromolecule. It is composed of two complement-ary strands wound around each other in a double helix.

Nucleotides - each single DNA strand is composed of repeating nucleotides. Nucleotides are made of three components - Phosphate, sugar pentose arranged lengthwise and nitrogen base attached to the sugar inwards which extends to join (by hydrogen bond) the complementary nitrogenous base from the other strand. Thus the two strands together make a ladder like arrangement, with the nitrogeneous bases forming the "rungs" of the ladder.

Four types of nitrogenous bases are found in DNA - Adenine, Guanine, Cytosine, Thymine. Adenine pairs with Thymine with 2 hydrogen bonds. Guanine pairs with Cytosine with 3 hydrogen bonds.



STRUCTURE OF DNA

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Histone Proteins

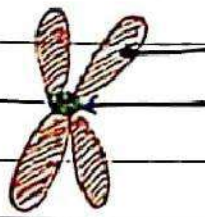
Histone are the proteins that help in the coiling and packaging of DNA into structural units called nucleosomes. DNA strand winds around a core of 8 histone proteins forming a complex called nucleosome. [just like a football around which a long rope is wound with one or two loops. A single human chromosome may have about a million nucleosomes. Each human cell (of about 6 µm in diameter) contains 2 m of DNA, which therefore needs to be condensed (coiled and supercoiled) in order to fit inside the nucleus.

Structure of Chromosome -

Chromosome consists of two sister chromatids joined at some point along the length. This point of attachment is called centromere. Centromere serves to attach to the spindle during cell division [discussed later in the chapter]

There would be as many chromatin fibres inside the nucleus as the number of chromosomes.

A Human chromosome



Genes - are specific sequences of nucleotides on a chromosome, that encode particular proteins which express in the form of some particular feature of the body.

Genes are units of heredity that are transferred from parents to offsprings.

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Now before going further let us take a short break. Answer the following questions during break

Q1. Name 4 nitrogen bases found in DNA

Q2. Name 3 components of a nucleotide.

Q3. Name the point of attachment of two sister chromatids in a chromosome.

Write the answers to above questions in notebook. Break is over children. Listen to correct answers

A1 Adenine, Guanine, Cytosine, Thymine

A2 Phosphate, Pentose sugar and Nitrogen base

A3 Centromere is point of attachment of two sister chromatids in a chromosome.

Need for new cells - Cell division.

1) Cell division is required for the growth of the organism.
2) Worn out cells are replaced by new cells formed through division of their parent cells.
3) Cut or injuries in the body (like cut in the skin or fracture in the bone) is repaired through cell division.
4) For reproduction - new organisms are produced by division of cells. In lower organism like bacteria by mitosis and in higher organisms by meiosis. Two types of cell division are -

Mitosis - It occurs in somatic (normal body) cells for growth, repair & replacement of cells. In this the new cells produced after division contains same number of chromosomes. New cells (daughter cells are exactly same as the parent cell.

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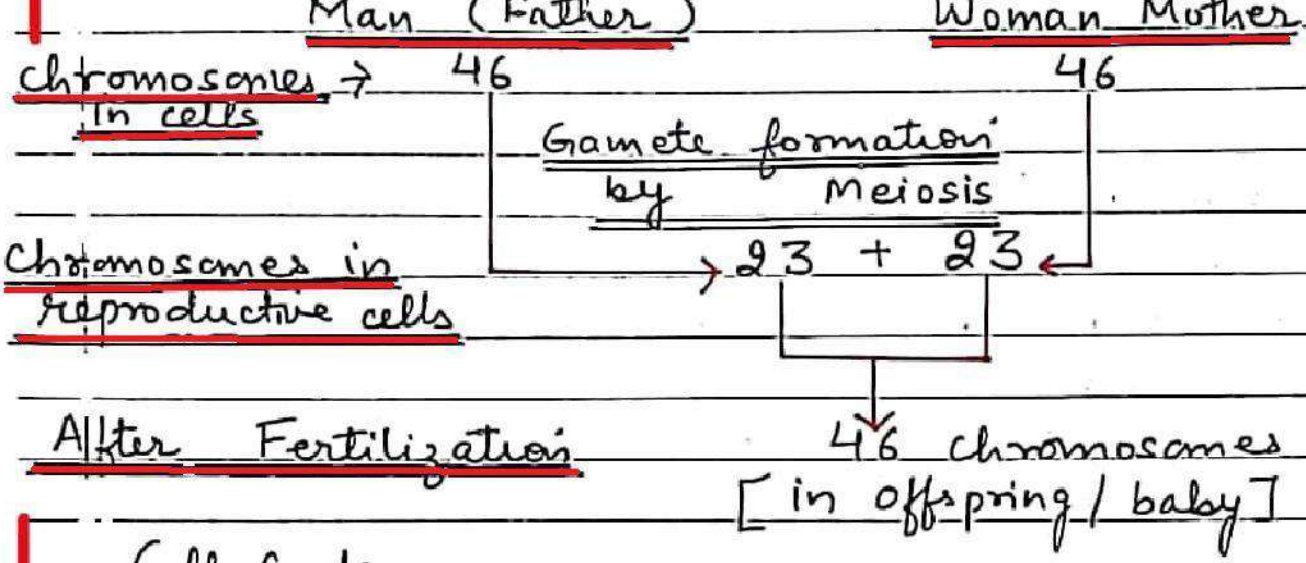
Meiosis - It occurs in reproductive organs [like eggs produced in ovaries of females and sperm produced in testes of males] Reproductive cells ie. eggs and sperms contain only half the number of chromosomes of their parent cells ie. one chromosome from each parent.

Because the chromosome number is reduced to half hence meiosis is called the reductional division. For eg in humans -



Cell Cycle

Before dividing the cell the cell grows, synthesizes materials like proteins, RNA etc. duplicates its DNA before physically splitting into two daughter cells. All these series of events form the cell cycle. Cell cycle consists of two phases -

(i) Non dividing phase called the - interphase.

(ii) Dividing phase called the M phase or mitosis.

Interphase [formerly called - Resting phase]

During this phase the small daughter cells (newly formed cells after cell division) grow in size and prepare for the next division.

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Cell cycle has 3 phases -

i) G1 phase - First growth phase - RNA and proteins are synthesized and volume of cytoplasm increases. Mitochondria and chloroplasts (which have their own DNA) divide. In late G1 phase, either the cell withdraws from cell cycle and enters a resting (or R) phase or start preparing for next division by entering the next synthesis phase S phase.

ii) Synthesis phase (S) - More DNA is synthesised and chromosomes are duplicated in this phase.

Second Growth Phase G_2 Phase Its shorter growth phase. RNA and protein are synthesised in this phase. Cell now enters into the dividing phase

Dividing phase of mitosis has 2 divisions -

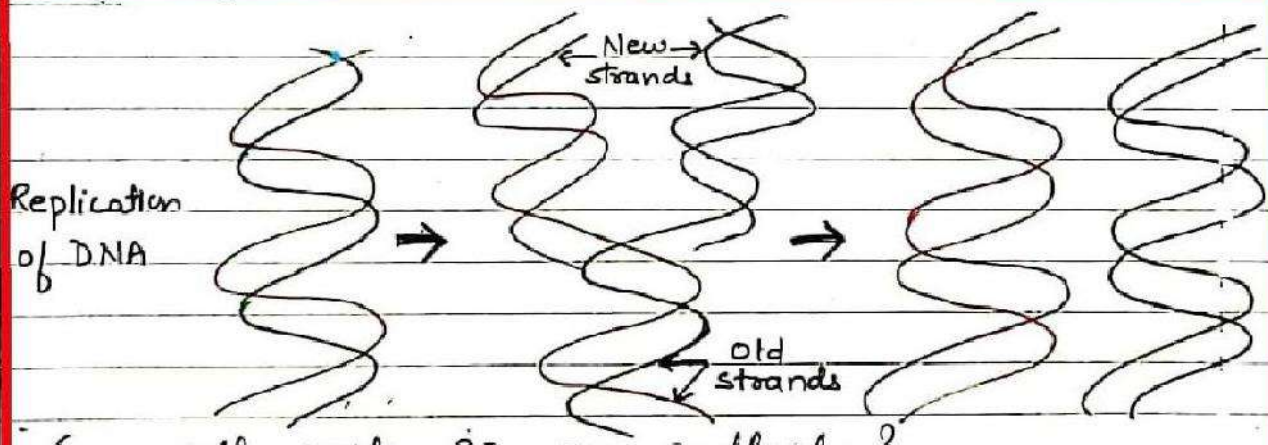
Karyo Kinesis - Division of nucleus. which further has following phases - Prophase, Metaphase, Anaphase and Telophase. After the division of nucleus, the cyto plasm of cell devides. Division of cytoplasm into the daughter cells is called Cytokinesis.

[Mitosis and its phases will be taken in detail in the next week's assignment:]

After the dividing phase gets completed, the newly formed daughter cells enter into interphase again and in this way the cell cycle goes on and on.

Formation of new DNA

During S phase of interphase, each DNA molecule duplicates For replication the DNA double helix opens at one end, making the two strands free to which new strands begin to form. and the process continues in a sequence for the whole length of DNA



Can cell cycle go on endlessly?
No. At some places it stops permanently at some places temporarily and at others till it is needed.
→ Brain cells once dead are not replaced
→ Liver cells divide once every 1-2 years
→ Surface skin cells are continuously dividing to replace lost damaged cells
→ In plants meristems divide rapidly
→ Germinal cells in ovary and testis divide to produce egg cells and sperms [gametes] through meiosis
→ Uncontrolled non stop division of cells leads to formation of tumours or cancers.

In children new cells being produced outnumber the dying cells
In adults, number of new cells produced equals the number of cells dying
In old age, number of new cells produced runs short of those that are dying.

HOME ASSIGNMENT -

1. Do the following questions from "Review questions" (given on Page 19-20 of your text book) in your notebook.

C. Short Answer type
Q No 1

D. Descriptive Type
Q No 3 and 4.

E. Structured / Application / skill Type
Q No 1.