The Living World

Chromosomes & CELL DIVISION

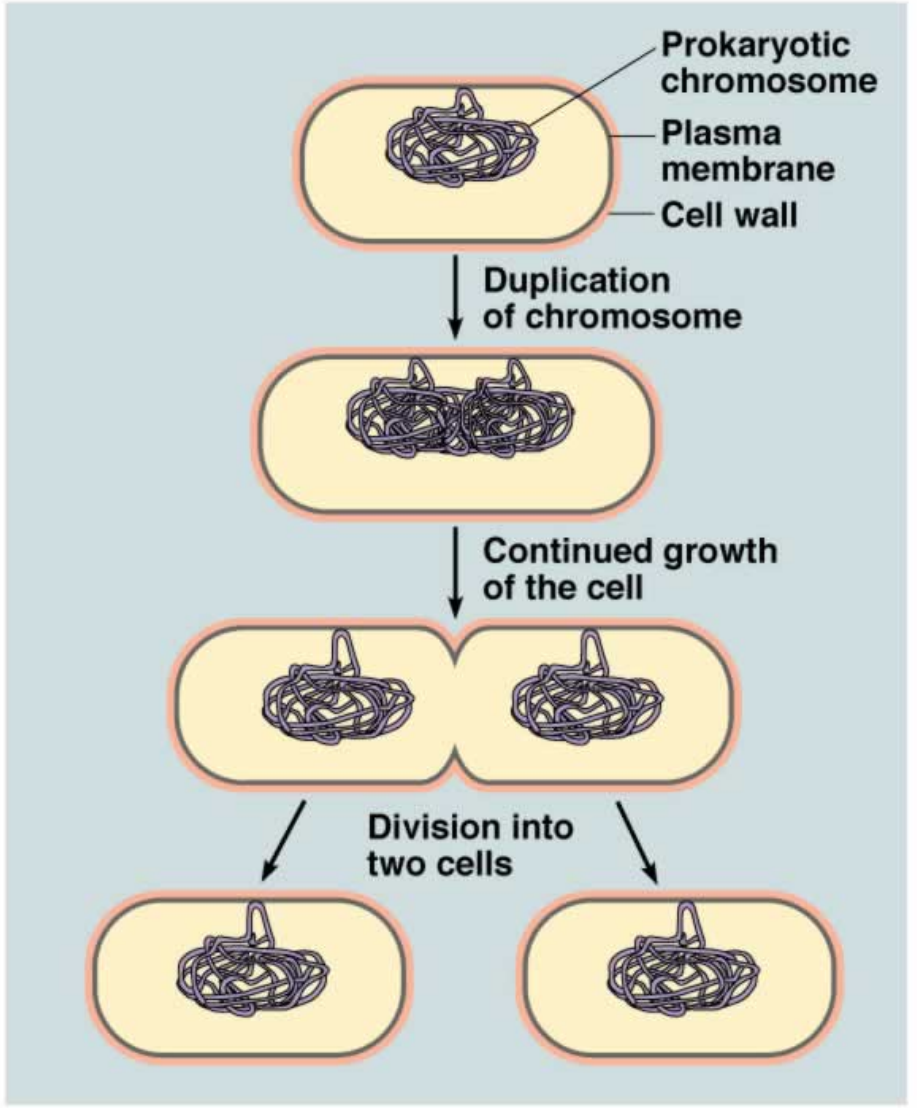
CELL REPRODUCTION

- Cell Division: process by which a cell divides to form two new cells (daughter cells)
- Three types of cell division, or cell reproduction
  - Prokaryotes (bacteria)
    - Binary fission divides forming two new identical cells
  - Eukaryotes
    - Mitosis
      - Cell or organism growth
      - Replacement or repair of damaged cells
    - Meiosis
      - formation of sex cells, or gametes

PROKARYOTIC CELL DIVISION

- Binary fission
  - 1: DNA Replication - DNA is copied, resulting in 2 identical chromosomes
  - 2: Chromosome Segregation - 2 chromosomes separate, move towards ends (poles) of cell
  - 3: Cytokinesis - cytoplasm divides, forming 2 cells

- Each new daughter cell is *genetically identical* to parent cell



Eukaryotic Cell Cycle

Like prokaryotic cell cycle, in that…

- Cell grows.

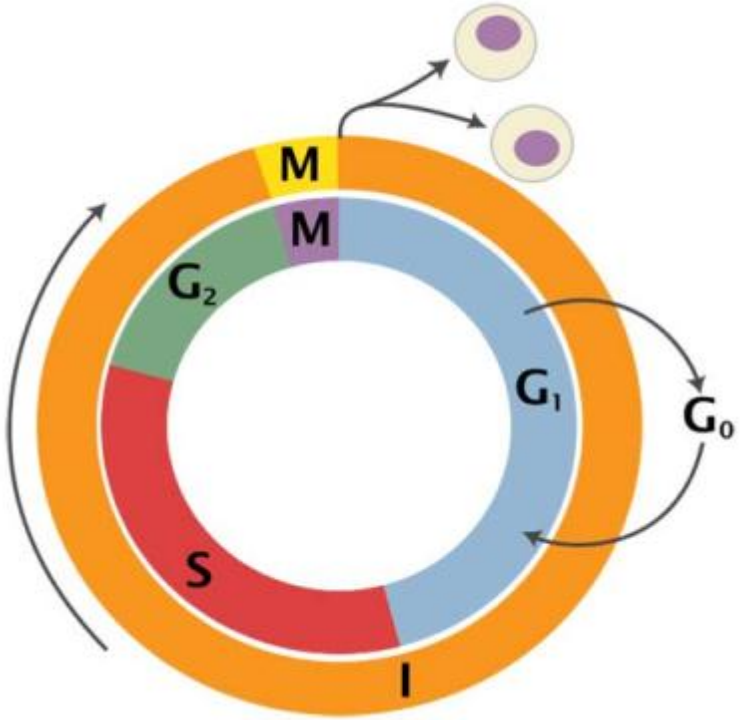
- DNA is replicated.

- Mitotic cell division produces daughter cell identical to the parent.

Different from prokaryotic cell cycle, in that…

- Eukaryotic cells have more DNA on many linear chromosomes.

- The timing of replication and cell division is highly regulated.

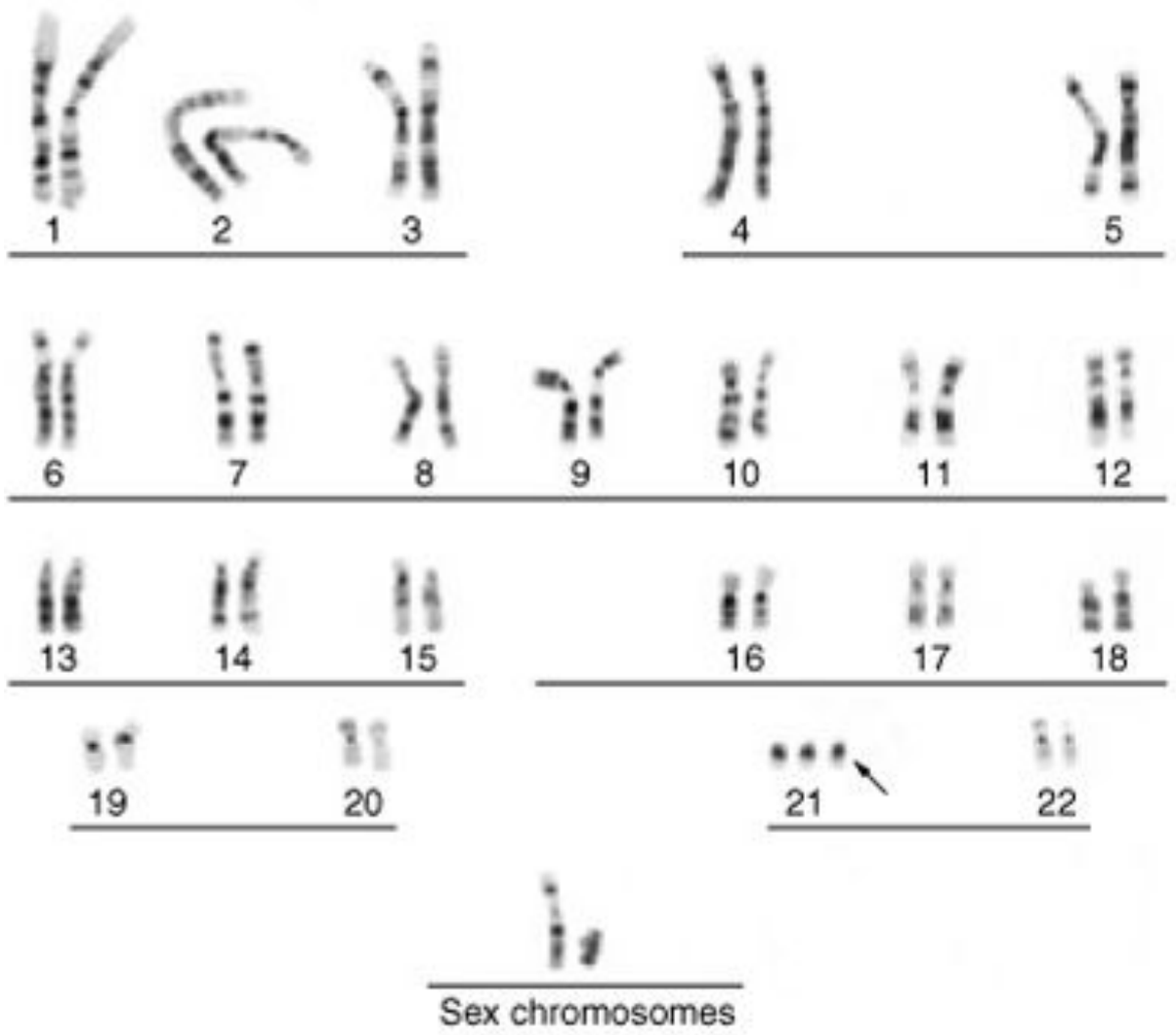


Discovery of chromosomes

- *Chromosomes were first observed by the German embryologist* **Walther Fleming** *in1882*
- *when he was examining the rapidly dividing cells of salamander larvae.*
- *Chromosomes are thread like structures that appear inside the nucleus at the time of cell division.*

What is a Chromosome?

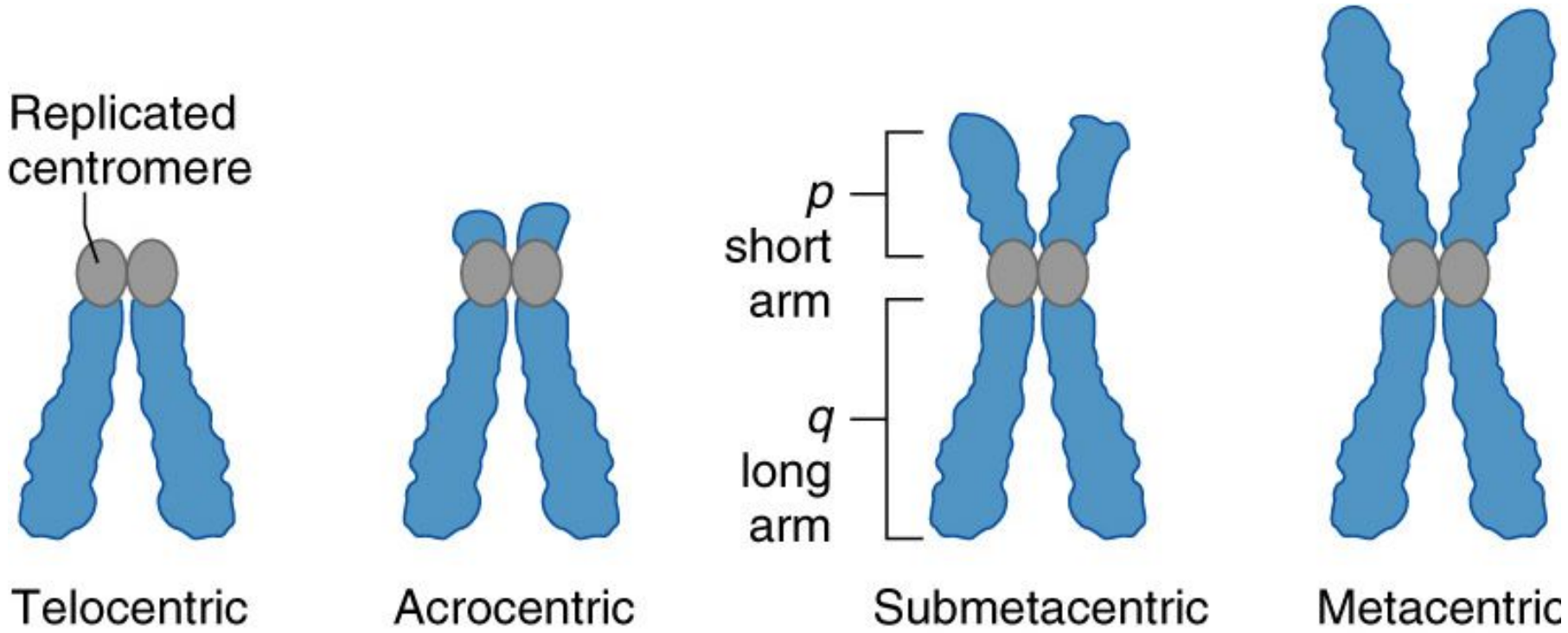
- Chromosome is the highly condensed form of DNA
- Wrapped into nucleosomes
- Wrapped into chromatin fiber
- Condensed during metaphase into the familiar shape
- Humans have 22 autosomal pairs
- And one pair of sex chromosomes



Chromosome Types:

1. Telocentric – no p arm; centromere is on end
2. Acrocentric – very small p arm; centromere is very near end
3. Submetacentric – p arm just a little smaller than q arm; centromere in middle
4. Metacentric – p and q arms are exactly the same length; centromere in exact middle of chromosome

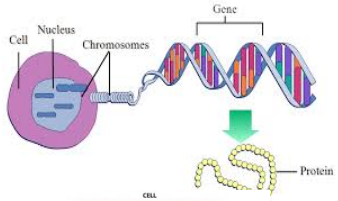
Chromosome Types:



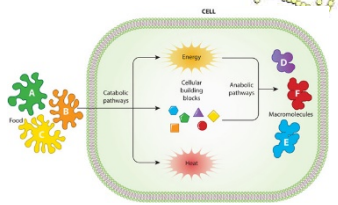
Functions of chromosomes

- Chromosomes contain genes and all the hereditary information is located in the genes.

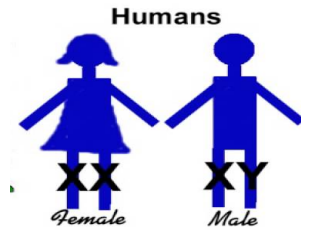
- Chromosomes control the synthesis of structural proteins and thus help in cell division and growth



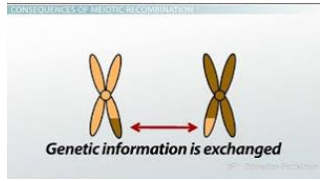
- They control cellular differentiation



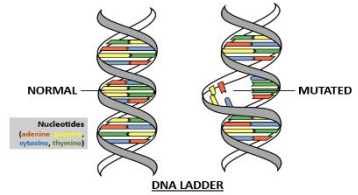
- By directing the synthesis of particular enzymes, chromosomes control cell metabolism
- Chromosomes form link between off springs and parents.



- Some chromosomes called as sex chromosomes determine the sex of the individuals
- Through the process of crossing-over, chromosomes introduce variations



- Mutations are produced due to changes in gene chemistry.



Autosomes/ Sex chromosomes

Human and animal chromosomes are categorized as **autosomes** or **sex chromosomes**.

Sex Chromosomes determine and organisim's sex.
All of the others are called **autosomes**

Typical human male

44 autosomes,
1 X sex chromosome
1 Y sex chromosome

Typical human female

44 autosomes,
2 X sex chromosomes

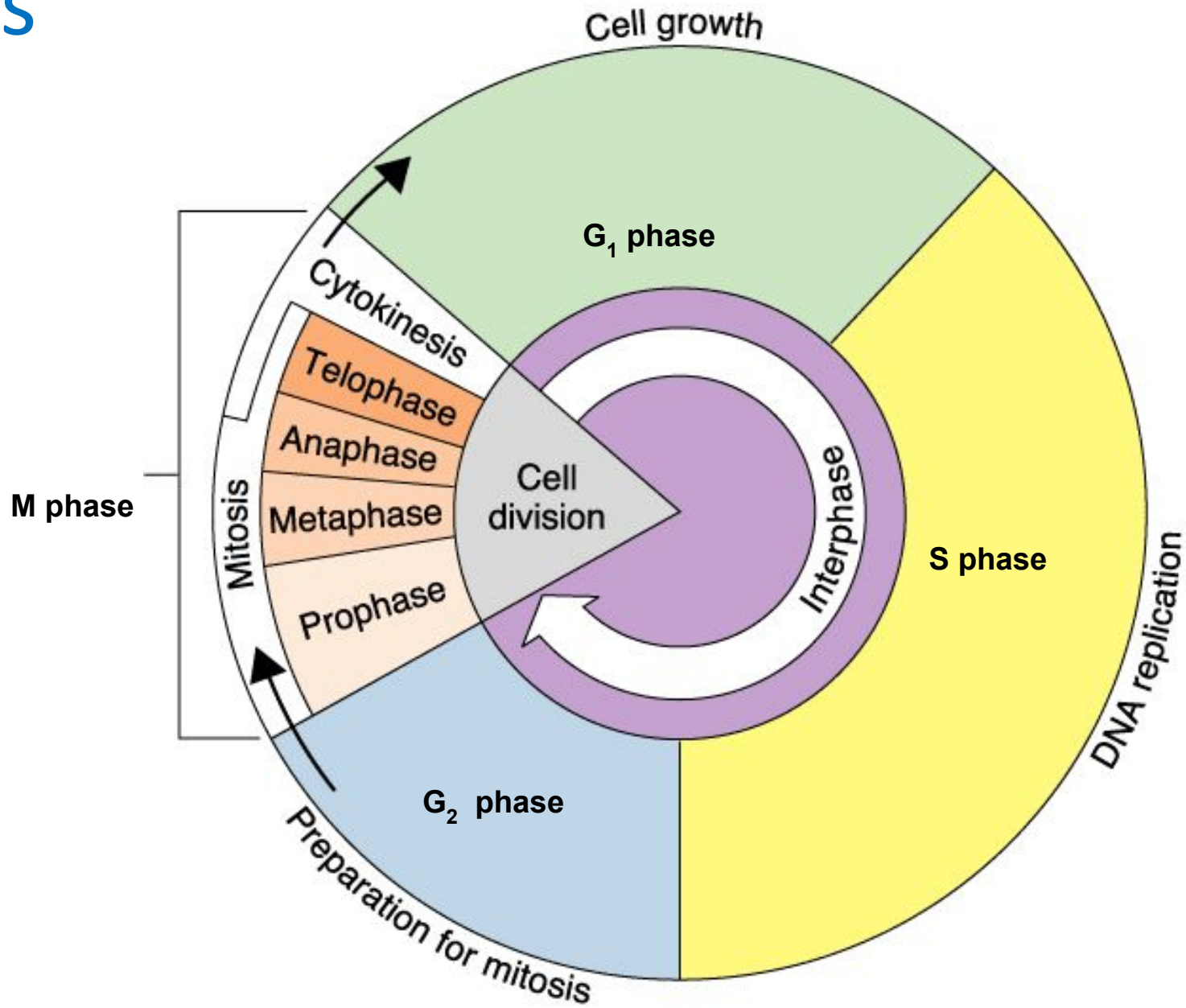
Questions

1. Define chromosomes and genes? What is the structure of chromosome?
2. What are the different types of chromosomes based on the position of centromere?
3. Explain sex chromosomes (allosomes) and autosomes?
4. What are the functions of chromosomes?
5. Define : Alleles, phenotype, geneotype, dominant and recessive genes

Questions

1. Define nucleotides and nucleosides? What are the composition of different nucleic acids?
2. What are the different bonds present in DNA and how are they formed?
3. What are the differences between DNA and RNA?
4. What are the salient features of the double helical structure of DNA proposed by Watson and Crick?
5. Explain Chargaff's rule with and example?
6. What are the functions of different types of RNA?

Mitosis


Cell growth
G_1 phase
Cytokinesis
Telophase
Anaphase
Metaphase
Prophase
Mitosis
M phase
Cell division
Interphase
S phase
DNA replication
G_2 phase
Preparation for mitosis

Meiosis

A division of the nucleus that reduces chromosome number by half.

- Important in sexual reproduction

- Involves combining the genetic information of one parent with that of the other parent to produce a genetically distinct individual

Cell Division –Meiosis

– the process in which the number of chromosomes in the original cell is **reduced** by **HALF** through the separation of **homologous** chromosomes

- Meiosis occurs in **sex** organs only
- Males (**XY**) – sex organs are the **testes** in humans
- Females (**XX**) – sex organs are the **ovaries** in humans
- Meiosis also occurs in the sex organs of other animals, plants, fungi, etc…

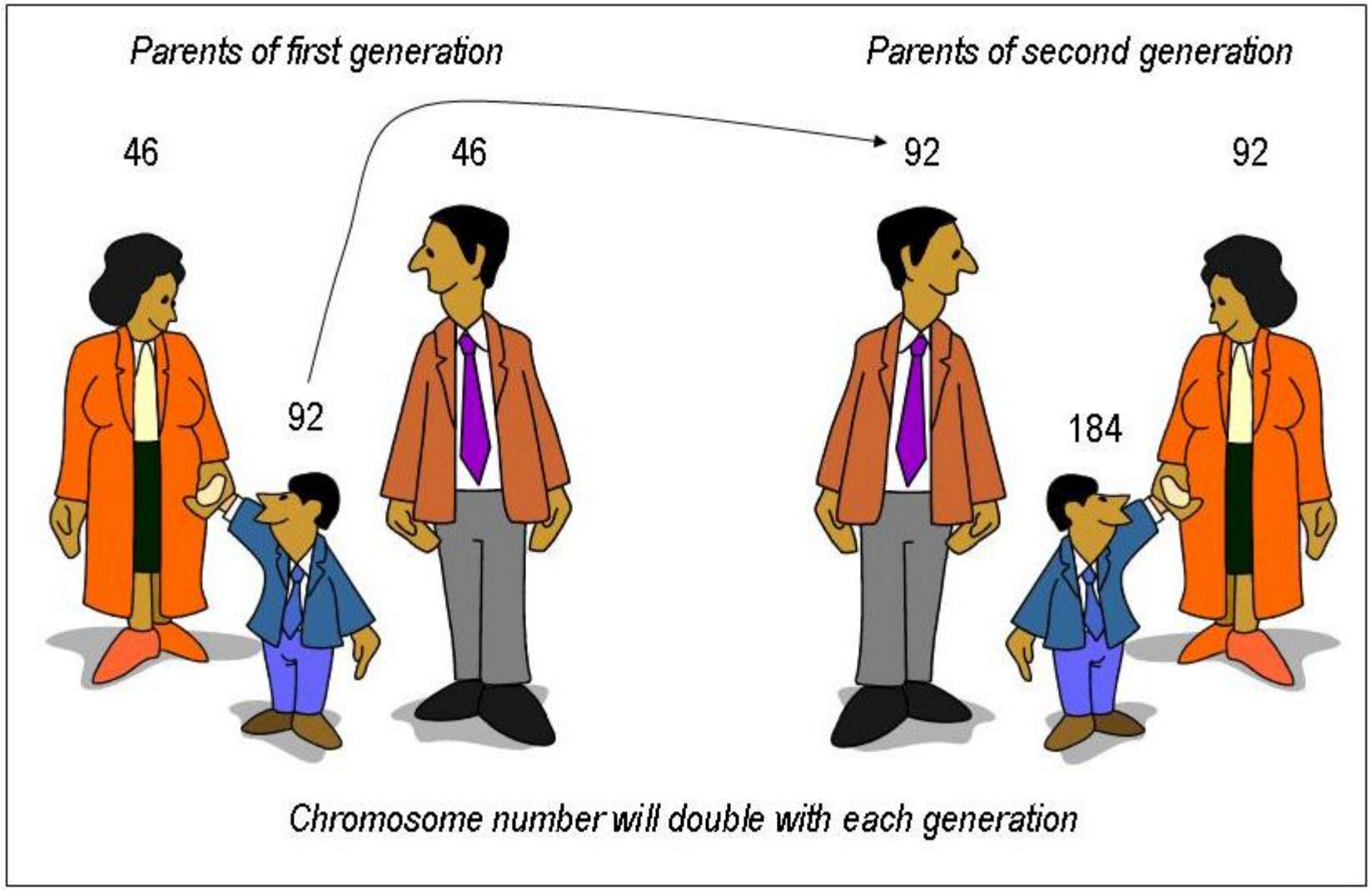
Terminology

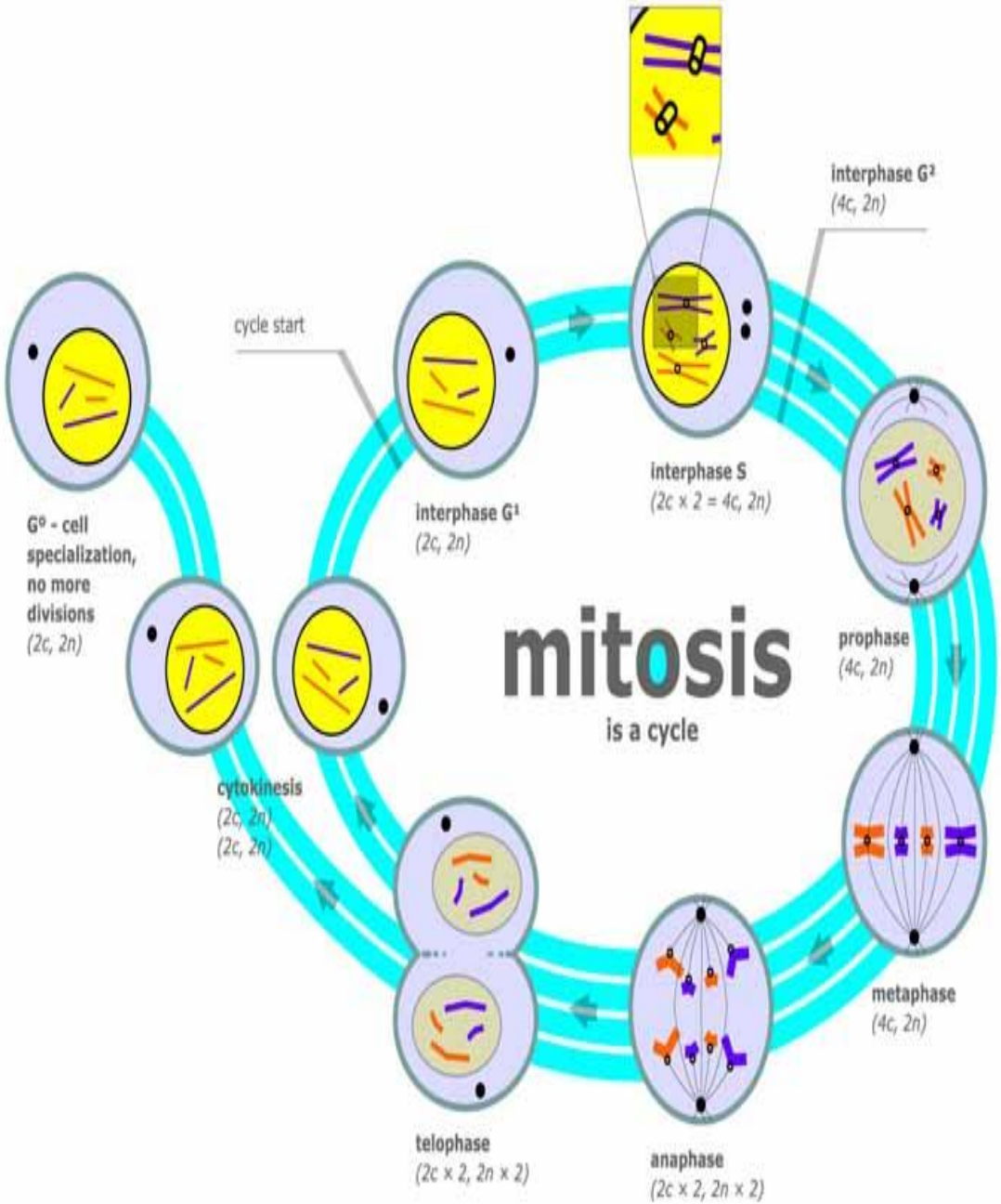
- ***Diploid*** - two sets of chromosomes (2n), in humans 23 pairs or 46 total
- ***Haploid*** - one set of chromosomes (n) - gametes or sex cells, in humans 23 chromosomes

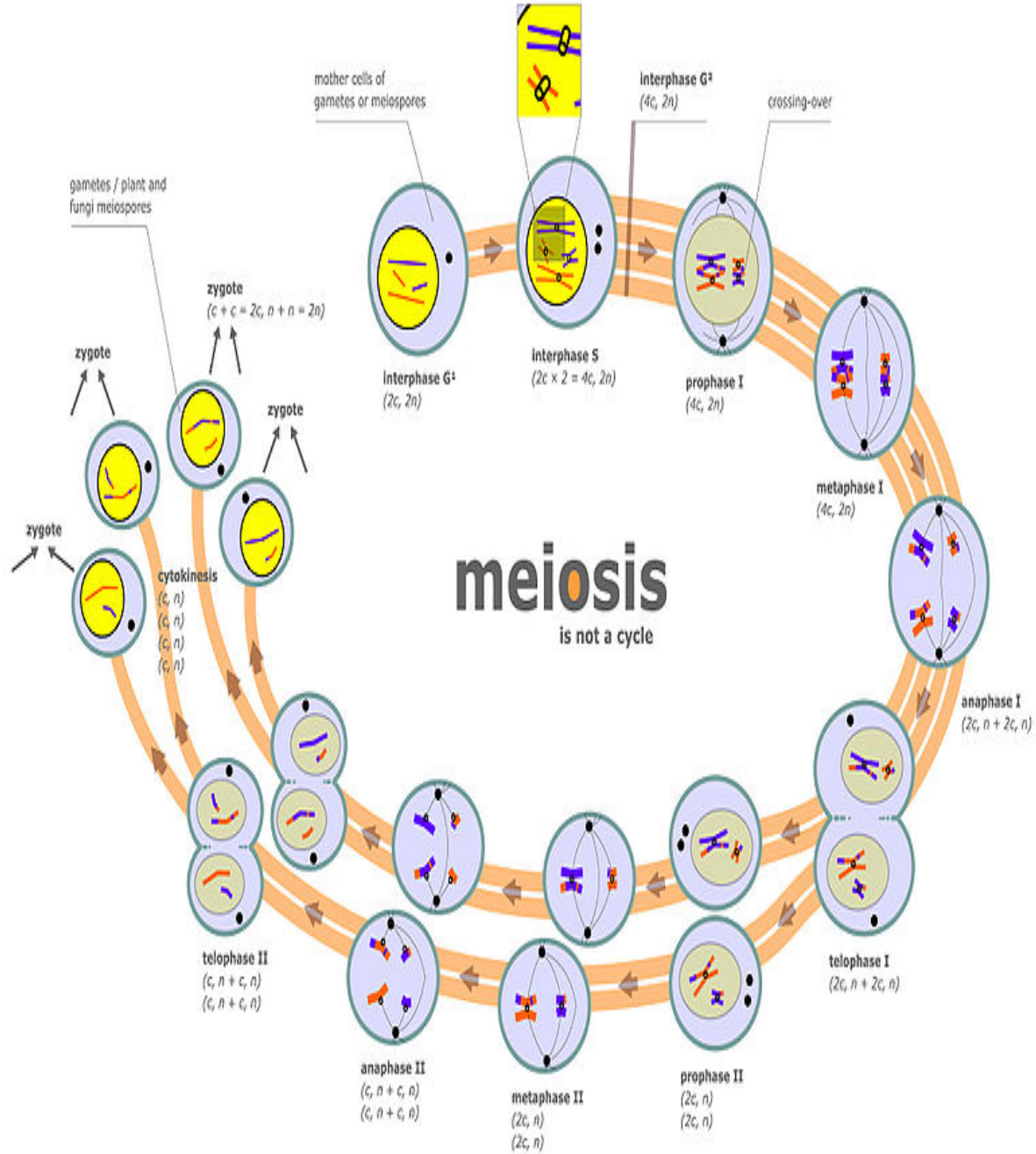
Chromosome Pairing

- ***Homologous pair***
  - each chromosome in pair are identical to the other (carry genes for same trait)
  - only one pair differs - sex chromosomes X or Y

WRONG!!!


Parents of first generation
Parents of second generation
46
46
92
92
92
184
Chromosome number will double with each generation


mitosis
is a cycle
cycle start
G⁰ - cell specialization, no more divisions
(2c, 2n)
interphase G¹
(2c, 2n)
interphase S
(2c × 2 = 4c, 2n)
interphase G²
(4c, 2n)
prophase
(4c, 2n)
metaphase
(4c, 2n)
anaphase
(2c × 2, 2n × 2)
telophase
(2c × 2, 2n × 2)
cytokinesis
(2c, 2n)
(2c, 2n)


meiosis
is not a cycle
mother cells of gametes or meiospores
interphase G¹
(2c, 2n)
interphase S
(2c × 2 = 4c, 2n)
interphase G²
(4c, 2n)
crossing-over
prophase I
(4c, 2n)
metaphase I
(4c, 2n)
anaphase I
(2c, n + 2c, n)
telophase I
(2c, n + 2c, n)
prophase II
(2c, n)
(2c, n)
metaphase II
(2c, n)
(2c, n)
anaphase II
(c, n + c, n)
(c, n + c, n)
telophase II
(c, n + c, n)
(c, n + c, n)
gametes / plant and fungi meiospores
zygote
(c + c = 2c, n + n = 2n)
zygote
zygote
zygote
cytokinesis
(c, n)
(c, n)
(c, n)
(c, n)

Thank You