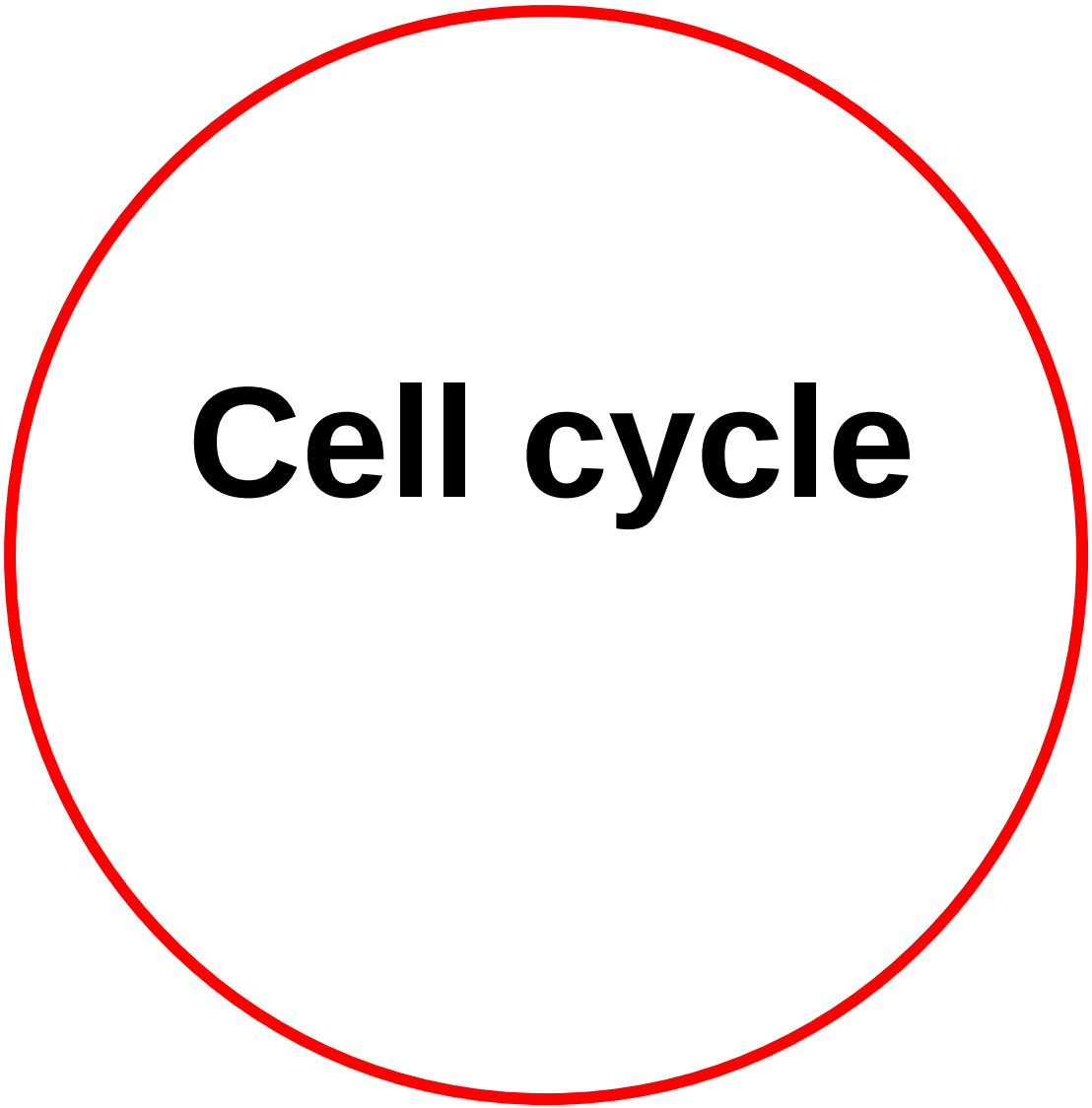

Cell cycle

Learning objectives

- Phases of cell cycle with Importance of each phase
- Why is Meiosis important?
- Behavior of the chromosomes in Meiosis I and Meiosis II
- Plan of DNA content and number of chromosomes in each type of cell division
- Differences between Mitosis and Meiosis

DEFINITION

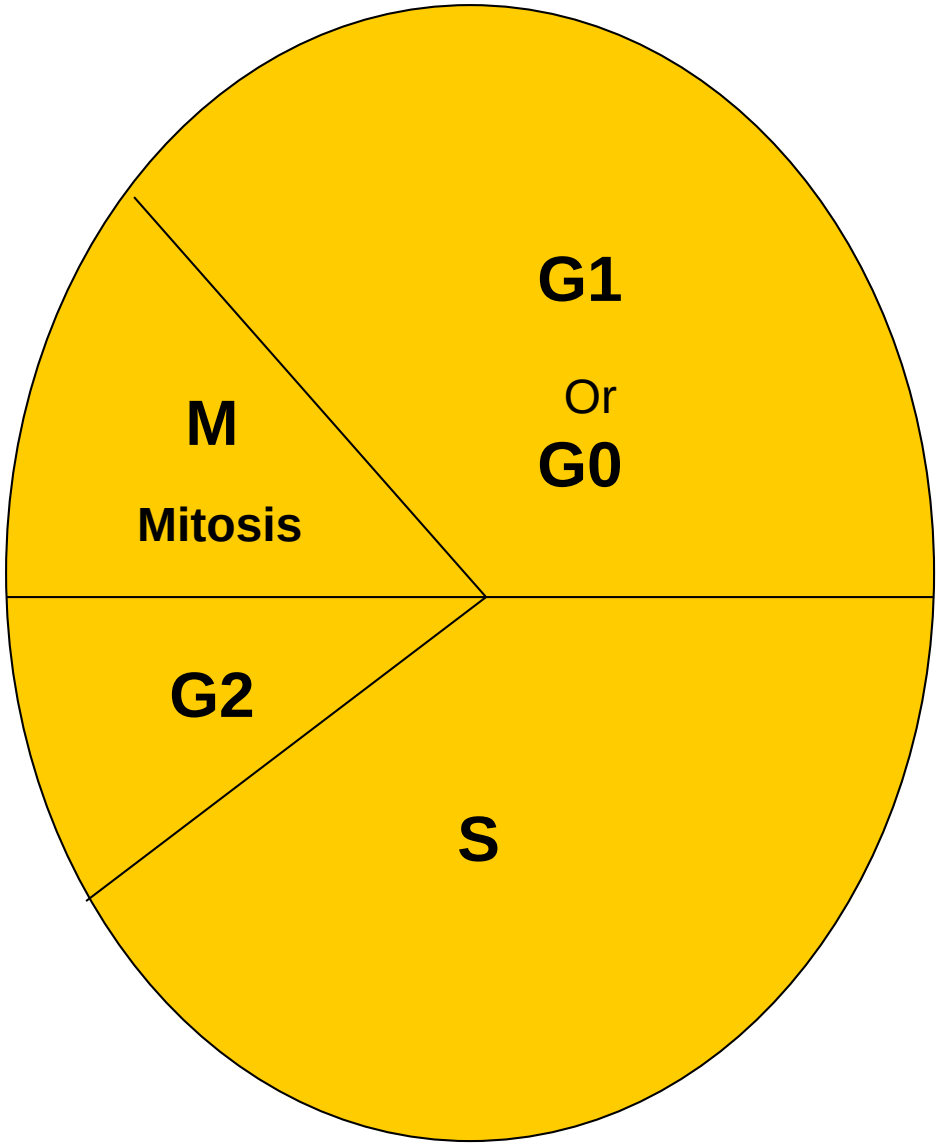
The time spent by the cell between **its own birth** and the **birth of its daughter cells**

Cell cycle

- Two Stages:

1. Mitosis (cell division)

2. Interphase



G0 can be converted to G1

If needed

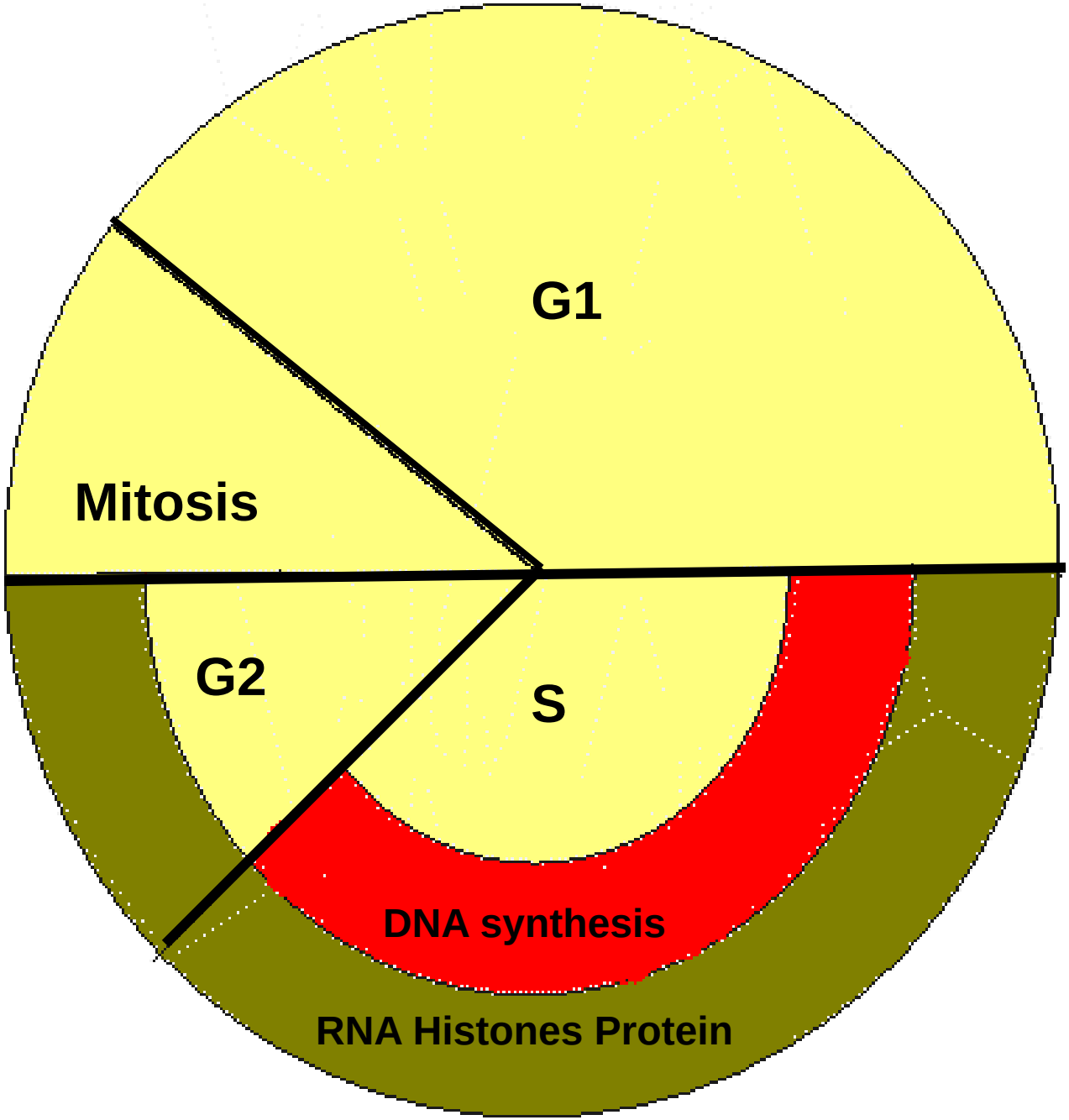
INTERPHASE

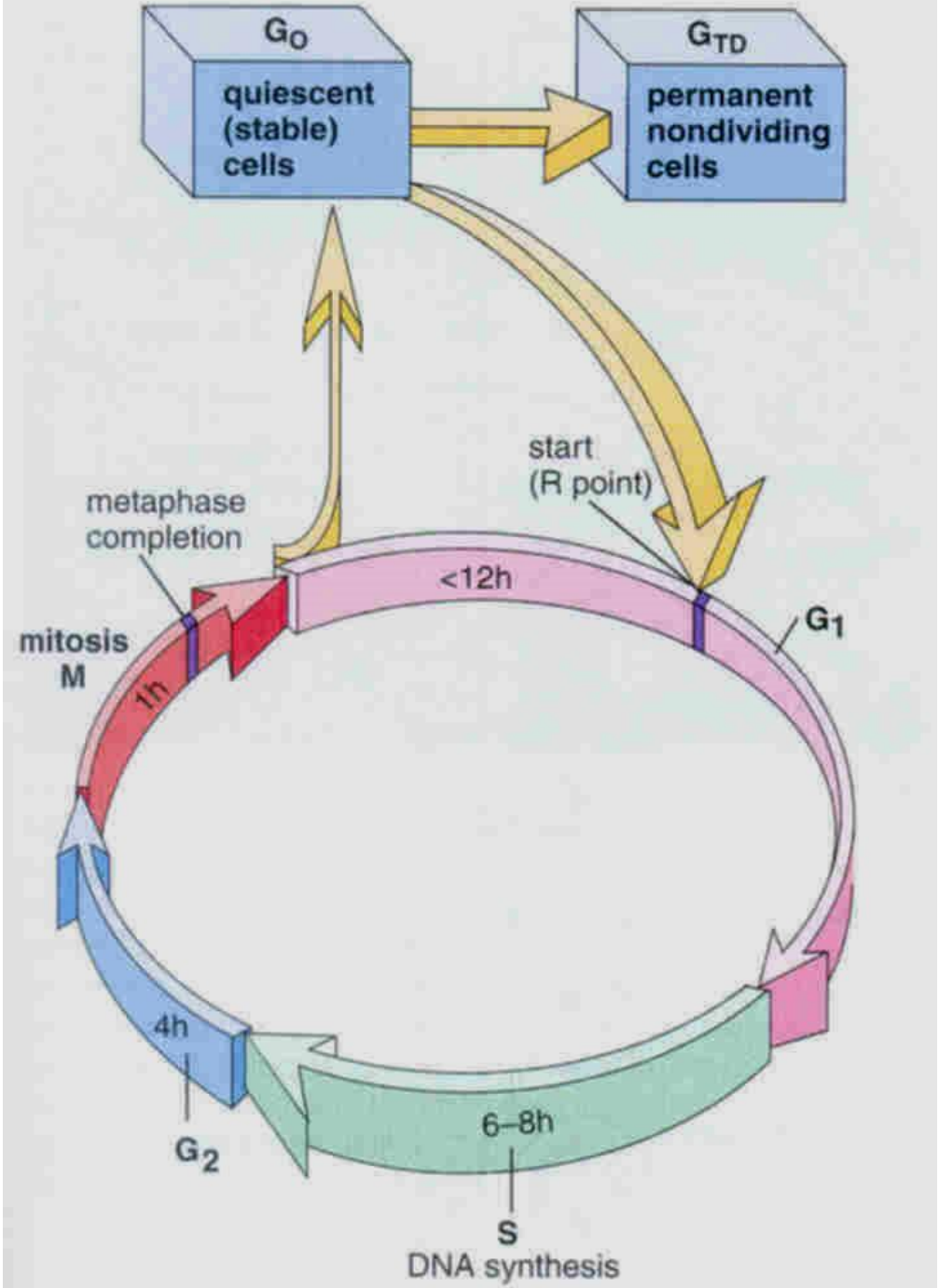
G1 + S + G2 = INTERPHASE

G1 – Gap1

G2 – Gap 2

S - Synthesis


G1
Mitosis
G2
S
DNA synthesis
RNA Histones Protein


G_O
quiescent (stable) cells
G_{TD}
permanent nondividing cells
start (R point)
metaphase completion
<12h
G_1
mitosis M
1h
4h
G_2
6–8h
S
DNA synthesis

CELL-CYCLE

- **Minimum TWELVE hours**
- **CELL DIVISION-** 1 HOUR
- **INTERPHASE** - 23 HOURS

- **G1 = 12 HOURS (10-12 hours)**
- **S = 07 HOURS (6-8 hours)**
- **G2 = 04 HOURS (2-4 hours)**

G 1

- Cell responds to **GROWTH FACTOR**
- Once the decision is made – it is irreversible

  Exceptions
- All molecular machinery for the future division is generated
- Tumour suppressor genes block G1
- Oncogenes work on G1

G 0

- Cells retain the capacity to proliferate

  But NO cell division

- Growth factor stimulates cells from

  G0 ⟶ G1 and S phase

  e.g. damage to Liver cells due to disease may induce G0 to G1

- **Neurons-Permanently remain in G0**

MOST CRUCIAL PHASE
and also vulnerable

G1

As tumor suppressor genes

or

Oncogenes act on it

S Phase -**DNA synthesis**

- Each chromosome replicates to become Bipartite
  - TWO Sister Chromatids - identical copies

- **DNA content is doubled but chromosome number remains same**

- **Diploid amount of DNA becomes Tetraploid**

- RNA , Proteins and histones are also synthesized

- Telomeres keep the integrity of the chromosomes during cell division

S Phase-- contd

Replication of DNA

is

- Not synchronous through all the chromosomes
- Not synchronous in a single chromosome
- Individual chromosomes have their own characteristic timings within the 6-8hours of S Phase
- Chromosome number remains same but it becomes double stranded

G2

- Cell ready for division
- Synthesis of RNA and Proteins continue in G2 Phase
- Cell enlarges doubling its total mass.


Screensavers.com

Cell Divisions

Mitosis:

- Single division of Somatic cells
- Crucial for growth and differentiation.
- Parent cell produces identical daughter cells, which Can undergo division on their own.

Meiosis:

-Two staged division of Sex/Germ cells creating **FOUR haploid Gametes.**

- Gametogenesis
- Parent cell divides and produces four gametes that are Not capable of further division.

Mitosis

A continuous process

2 Daughter cells have

SAME

DNA content(Diploid)

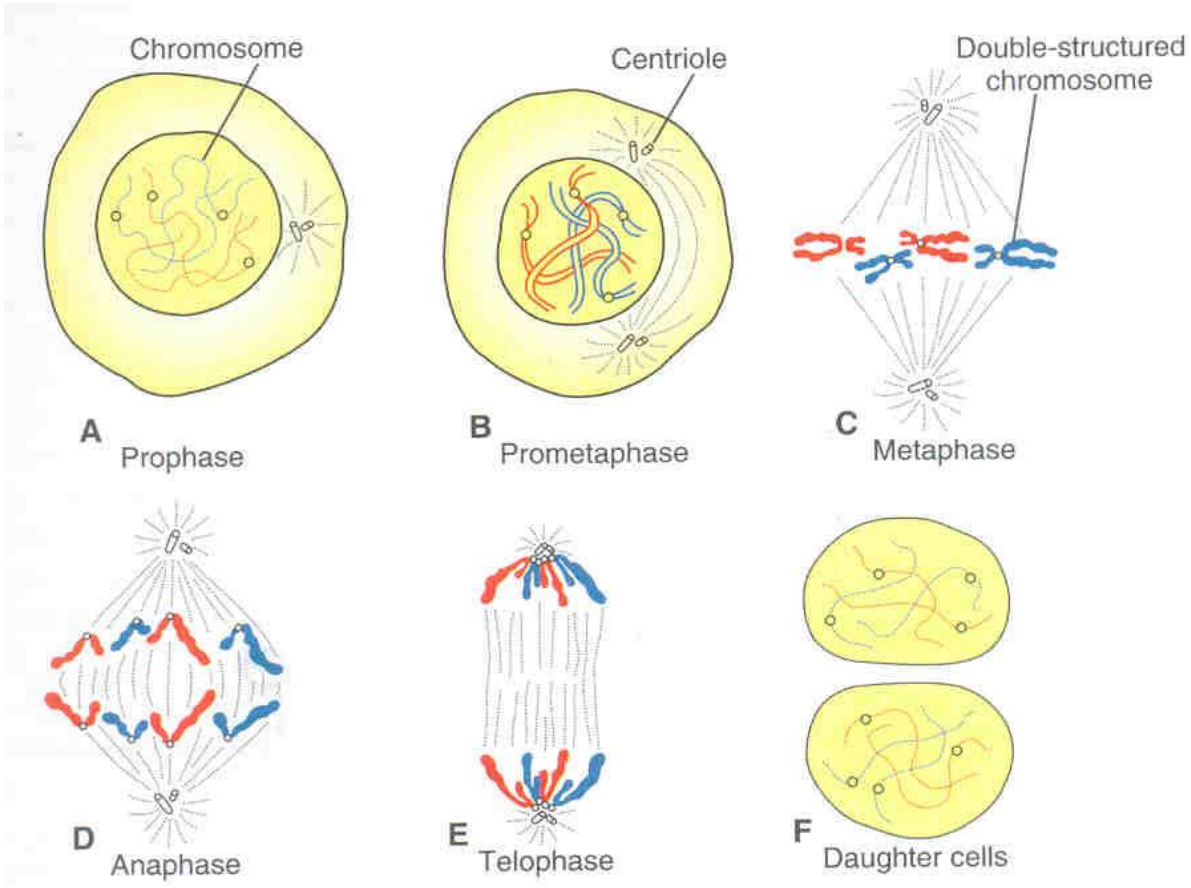
and

Chromosomal number(23 pairs)

Like

Parent

S phase is **CRUCIAL** for Mitosis


Chromosome
A
Prophase
Centriole
B
Prometaphase
Double-structured
chromosome
C
Metaphase
D
Anaphase
E
Telophase
F
Daughter cells

PROPHASE

- Condensation Of Chromosome
- Beginning Of Formation Of Mitotic Spindles By Microtubules
- Centrioles Position Themselves To Opposite Poles
- Microtubules Organize From Poles To The Centre Of The Cell

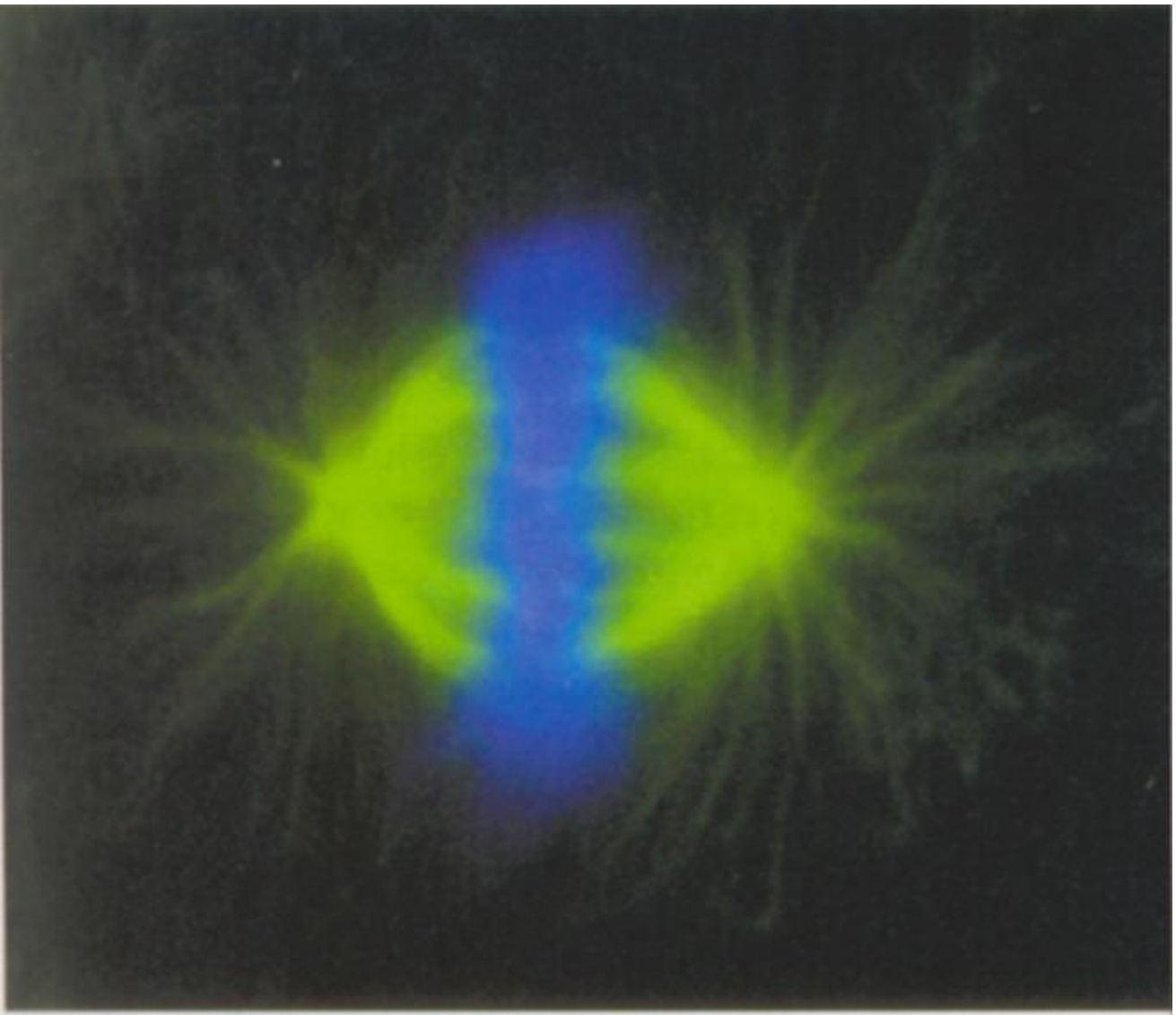
PROMETAPHASE

- Nuclear Membrane Starts To Disintegrate
- Chromosomes Disperse Within The Cell
- Chromosomes Move To The Equator Of The Cell
- Microtubules Attach To The Kinetochore

METAPHASE

- Maximum Condensation Of The Chromosomes
- Positions Balanced By The Equal Force From Microtubules
- The Stage When Chromosomes Are Most Readily Seen

Metaphase Mitotic Spindle

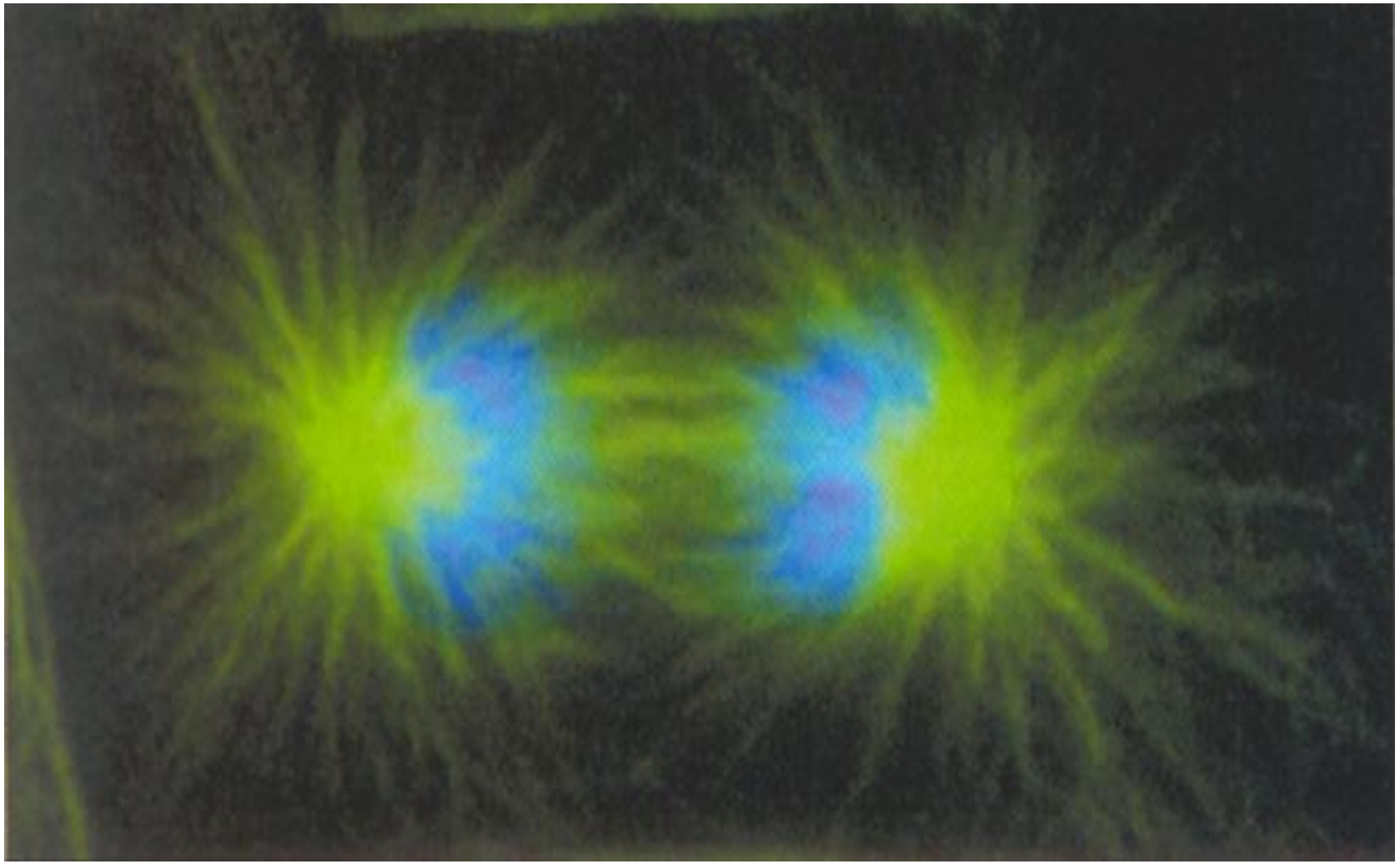


- Blue- DNA
- Green- Tubulin in microtubules

ANAPHASE

- Sister Chromatids Now Become Independent Daughter Chromatids
- Chromatids Move To Opposite Poles

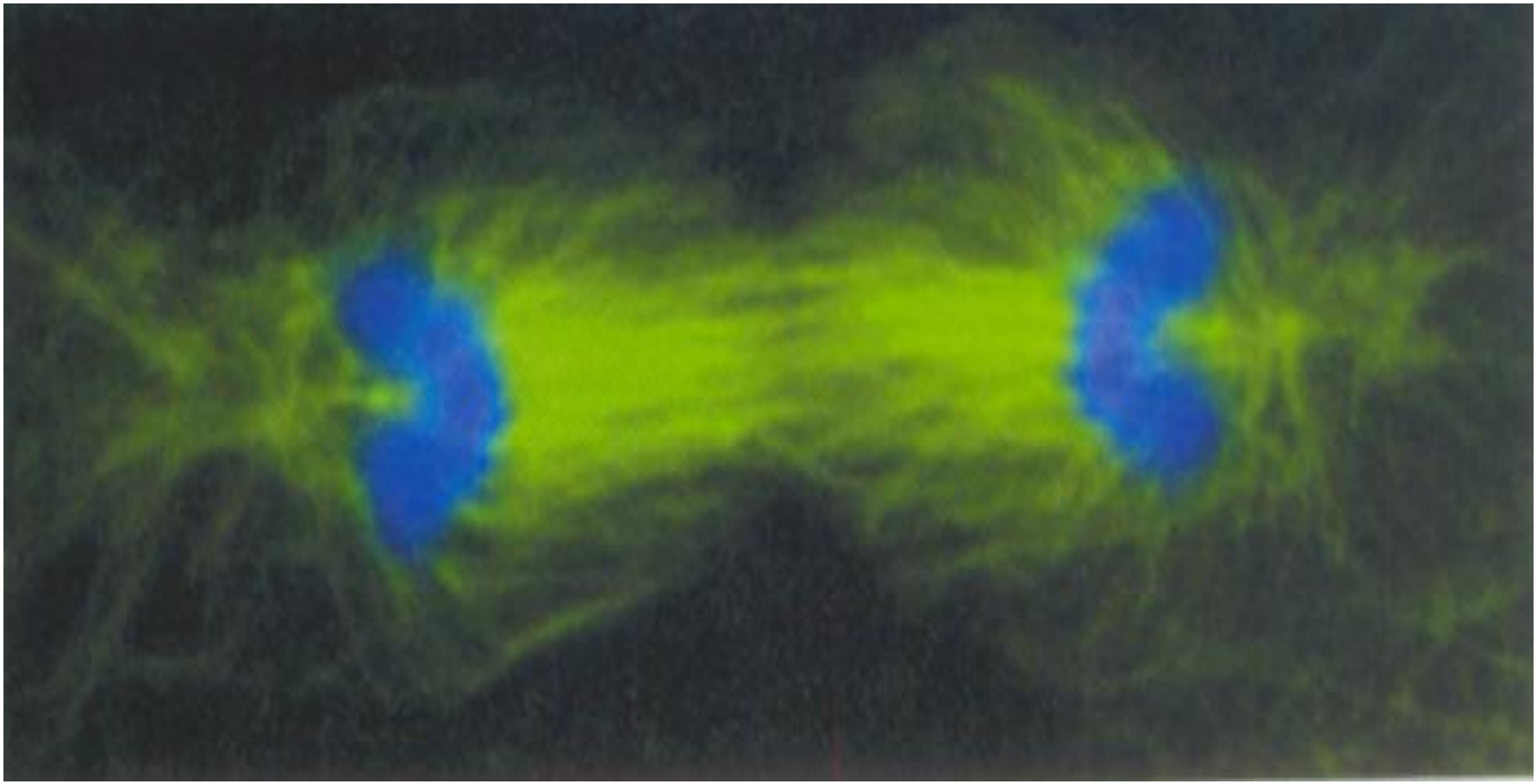
Anaphase

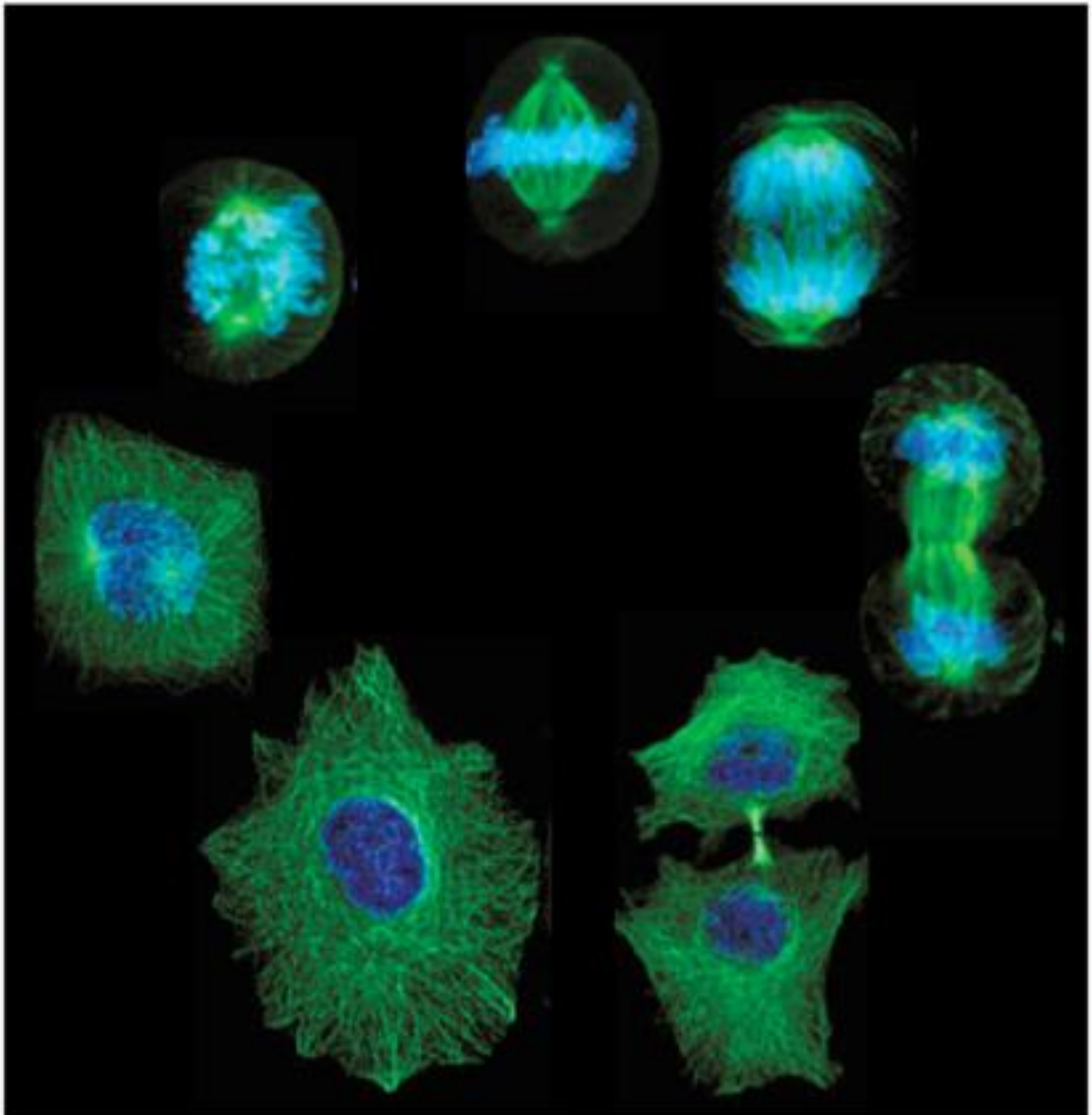


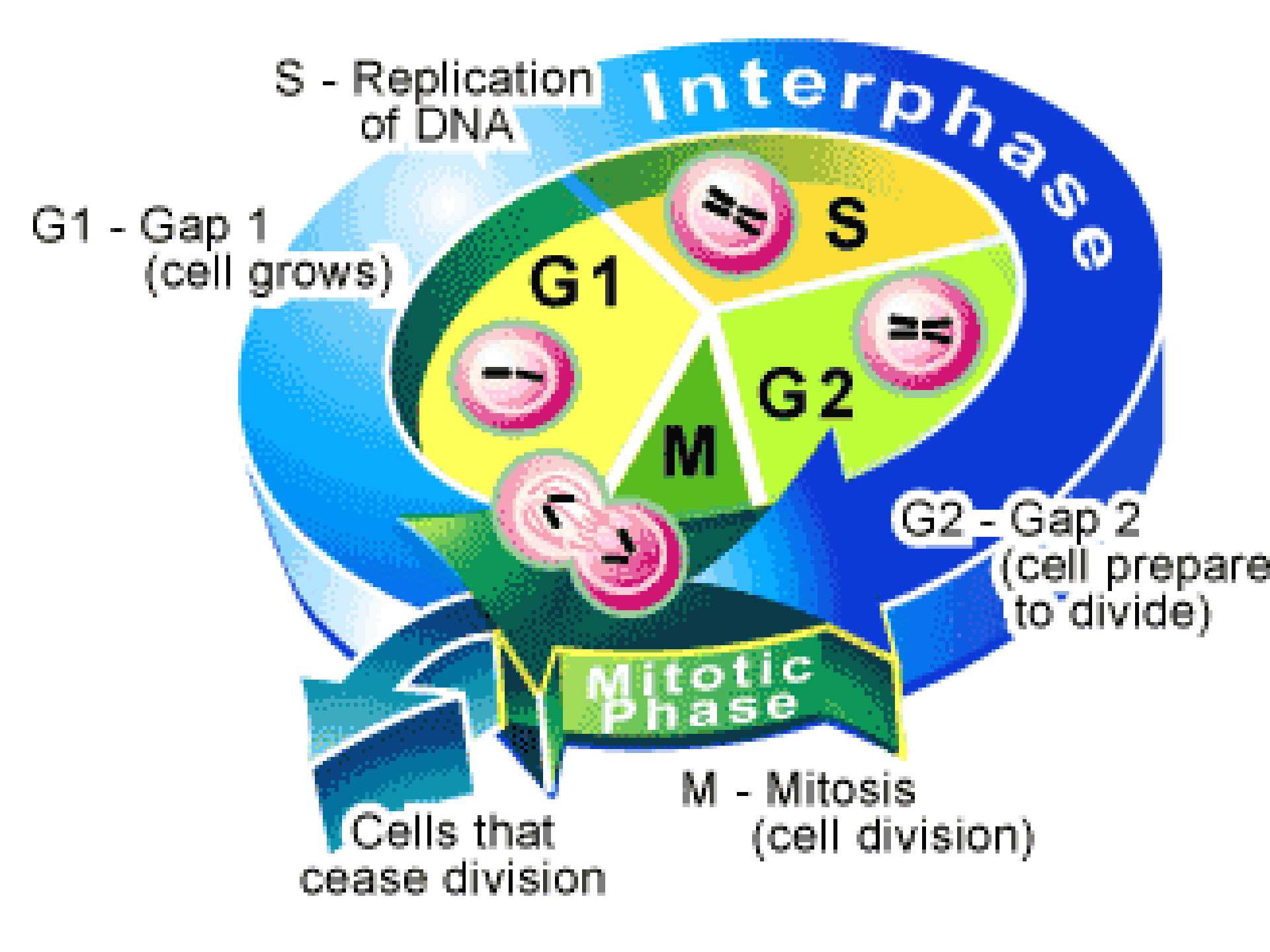
TELOPHASE

- Nuclear Membrane Reforms
- Cytoplasmic Cleavage
- Equal Division Of Cytoplasm With Cytoplasmic Organelles

Telophase






S - Replication
of DNA
Interphase
G1 - Gap 1
(cell grows)
G1
S
G2
M
G2 - Gap 2
(cell prepare
to divide)
Mitotic
Phase
Cells that
cease division
M - Mitosis
(cell division)

Overview

The cell cycle consists of

G_1 phase, the first growth phase

S phase, during which the DNA is replicated, where S stands for the Synthesis of DNA.

G_2 phase is the second growth phase, also the preparation phase

M phase or mitosis and cytokinesis, the actual division of the cell into

" two daughter cells"

The cell cycle stops at several checkpoints and can only proceed if certain conditions are met, for example, if the cell has reached a certain diameter.

Meiosis

- Process : **DILPOID** Cells To **HAPLOID** Gametes
- It Is Unique To Germ Cells
- Consists of only **ONE** Round Of S- Synthesis Followed By **TWO** Rounds Of Cell Division
  (Chromosomal Segregation)
- Male And Female Gametes Have Different History.
- Events Are Same But Timings Are Very Different

MI

- Recombination of genes

- Chromosome number is reduced to half

Meiosis

Stage 1…..M-I

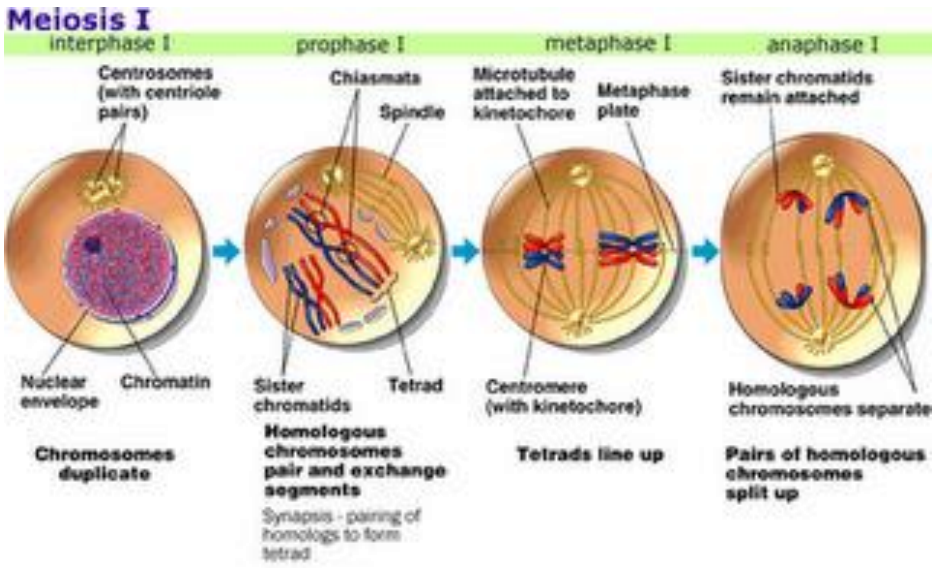
- Preparation of cell division
- S phase is present so the DNA Amount is Tetraploid
- Resultant daughter cells have……

Diploid amount of DNA and

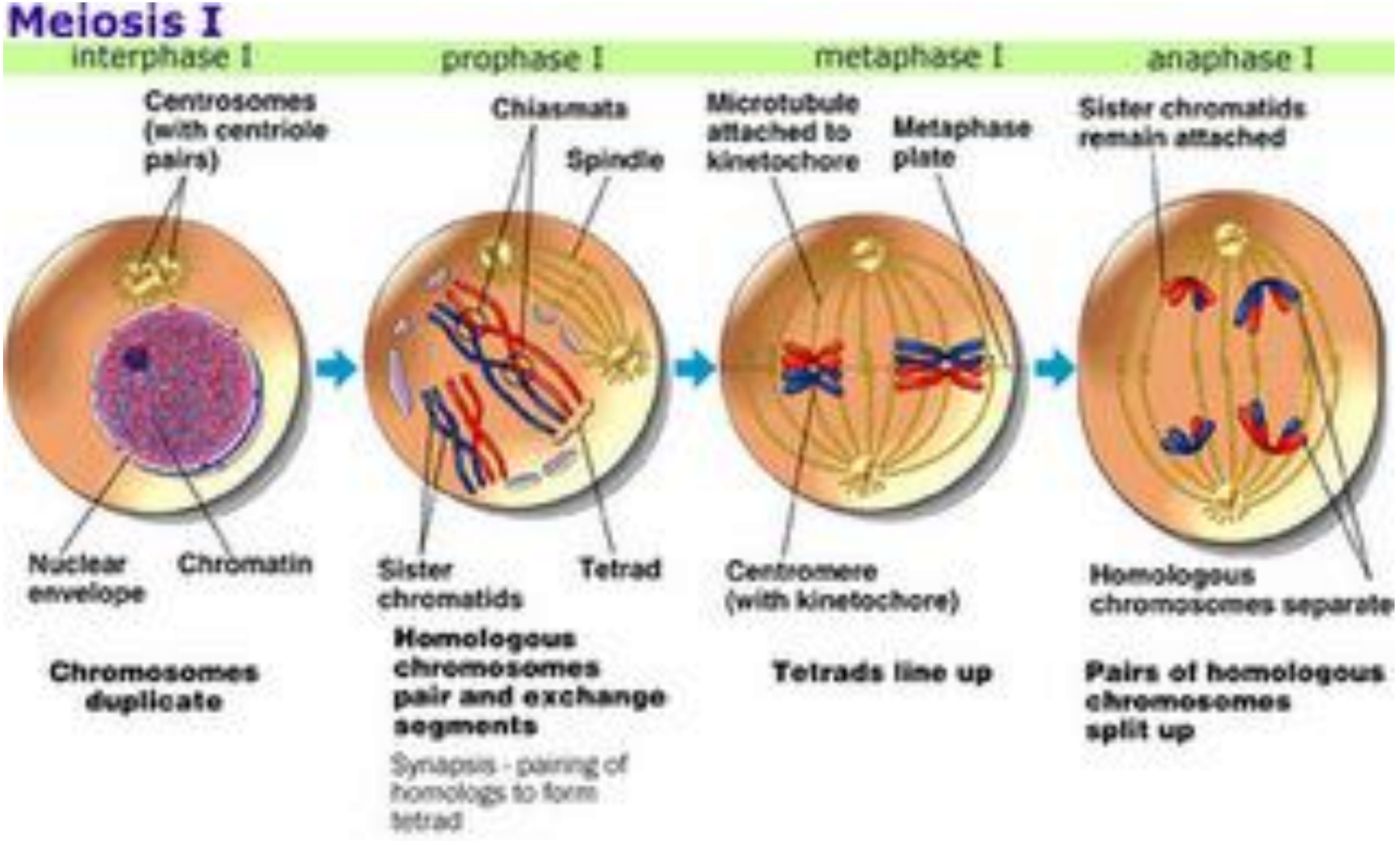
Haploid number chromosome

(Double Stranded)


MEIOSIS I


Meiosis I
interphase I
prophase I
metaphase I
anaphase I
Centrosomes (with centriole pairs)
Chiasmata
Spindle
Microtubule attached to kinetochore
Metaphase plate
Sister chromatids remain attached
Nuclear envelope
Chromatin
Sister chromatids
Tetrad
Centromere (with kinetochore)
Homologous chromosomes separate
Chromosomes duplicate
Homologous chromosomes pair and exchange segments
Synapsis - pairing of homologs to form tetrad
Tetrads line up
Pairs of homologous chromosomes split up

Meiosis I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Homologous chromosomes pair and exchange segments
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Microtubule attached to kinetochore
Metaphase plate
Centromere (with kinetochore)
Tetrads line up
Sister chromatids remain attached
Homologous chromosomes separate
Pairs of homologous chromosomes split up

Prophase I

- The chromosomes condense and migrate towards the nuclear envelope.
- Each chromosome is made up of two identical chromatids, known as sister chromatids.
- Formation of spindle fibers.
- Synapsis or pairing of homologous chromosomes takes place.
- The homologous chromosomes interchange equivalent sections of chromatids, which is a process known as crossing over.
- The chromosomes undergo thickening and move away from the nuclear envelope.
- The nuclear envelope and nucleoli disappear.

MI

Long Prophase
Divided in 5 stage

Crossing Over or **GENETIC RECOMBINATION**

Completed in first Four stages of Prophase

Most Vital phase for evolution

Leptotene

- Visible threads—condensation begins

Zygotene

- Homologous chromosomes begin to align along their

entire length

with

SYNAPSIS

at corresponding DNA sequences

Pachytene

- Chromosomes Are Tightly Coiled
- Each Pair Appears As Bivalent(Tetrad)
- Meiotic **Crossing Over** Takes Place

Diplotene

- Synaptinemal Complex Breaks Down
- Two Components Begin To Separate
- Only Chiasma Holds Them Together
- Average Number Of Chiasmata -50

Metaphase I

- Pairing of bivalents or homologous chromosomes in the equatorial plane, in the center of the cell.

- The centromeres, a region in the chromosome where the chromatids are held together, are located in the opposite poles.

Anaphase I

- The chromosomes migrate to the opposite poles of the cell.
- The sister chromatids are not separated, but remain together.

Telophase I

- The chromosomes continue to migrate towards the poles.
- Both the poles have haploid number of chromosomes.
- Condensation of the chromosomes and cytokinesis (division of cytoplasm) take place
- Nuclear envelope starts forming.
- Two daughter cells with haploid chromosome number are formed.

Meiosis I - important events

CROSSING OVER

- Homologous pair comes in contact with the member of the **pair-Join**
- Exchange of the genetic material
- **Pair disjoins**
- **Separates and moves to opposite pole in Anaphase**

Meiosis II

Comprises the following four stages:

Prophase II

- The nucleoli and nuclear membrane are separated.
- The chromosomes start moving towards the equatorial plane.
- The two sister chromatids are still held by the centromere.

Metaphase II

- The chromosomes are aligned in the equator.
- The centromeres are oriented towards the opposite poles.

Anaphase II:

- The sister chromatids held at the centromere are separated by the spindle fibers.

Telophase II:

- Four nuclei (two each in a daughter cell) are formed, along with the process of cytokinesis.

- Each of the four nuclei develops a nuclear envelope.

- Four daughter cells or gametes are formed.

MII

No gap between MI and MII

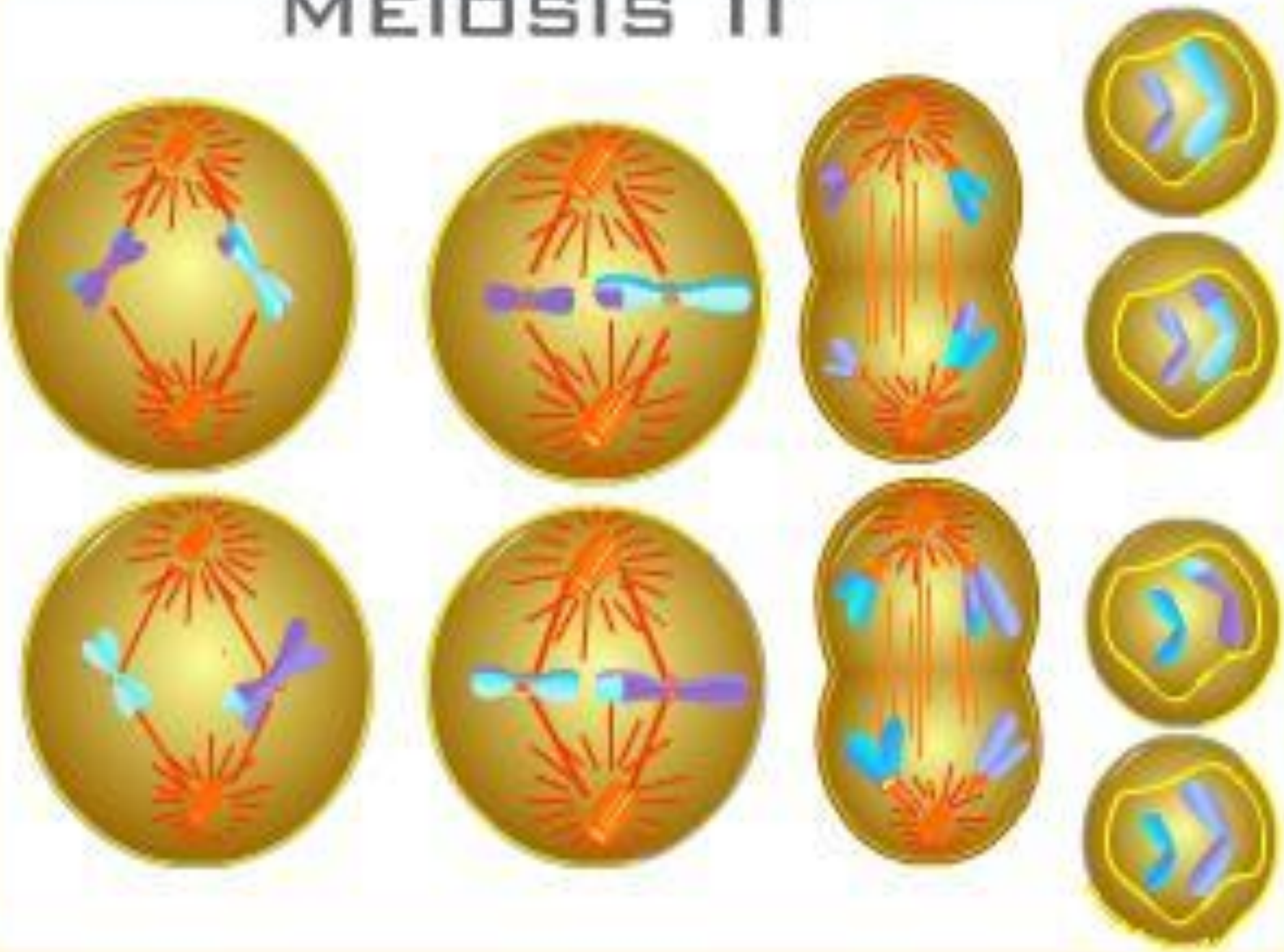
Therefore

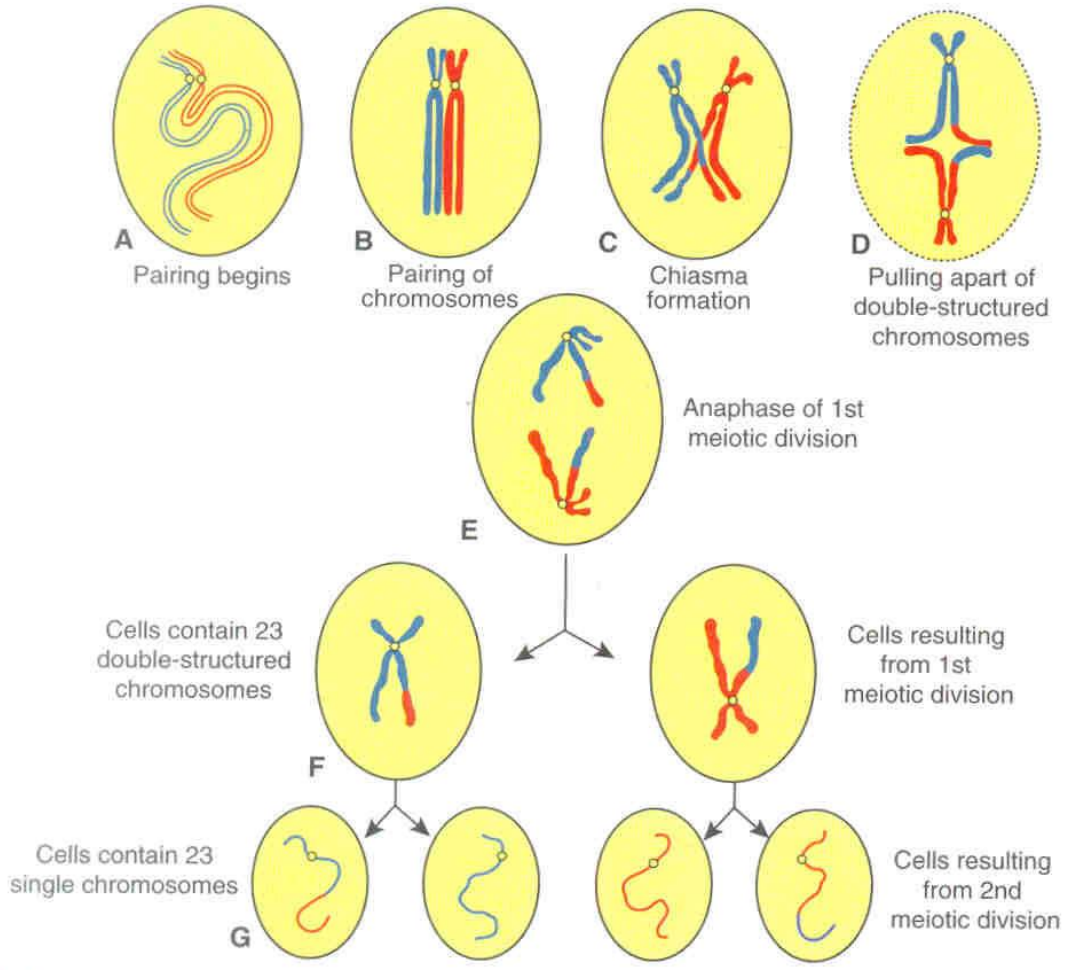
NO DNA Synthesis Or Replication

Prior To The Division

NO Synthesis phase

Meiosis II




A
Pairing begins
B
Pairing of chromosomes
C
Chiasma formation
D
Pulling apart of double-structured chromosomes
E
Anaphase of 1st meiotic division
Cells contain 23 double-structured chromosomes
F
Cells resulting from 1st meiotic division
Cells contain 23 single chromosomes
G
Cells resulting from 2nd meiotic division

Meiosis

Second stage-MII is Like Mitosis

No Prior S phase-

Crucial to have haploid Gamete

- Resultant daughter cells have

1)Haploid Amount of DNA and

2)Haploid number of (single stranded) Chromosomes
Cytoplasmic division unequal in females
and not fully complete in males

Genetic consequences of MEIOSIS

- Reduction of the chromosome number

  Diploid to Haploid

- Shuffling of genetic material by random assortment of the homologous chromosomes

- Additional shuffling of genes by crossing over which is critical for disjunction

- Segregation of alleles either at M-I or MII

Cell Behaviour

Cell fusion

- Cytoplasmic mass with common nuclei- e.g.Skeletal Muscle

Apoptosis

- Internal activation of Suicide programme

It is a controlling mechanism of the growth

Necrosis

- Death of a cell due to tissue injury


THANK YOU