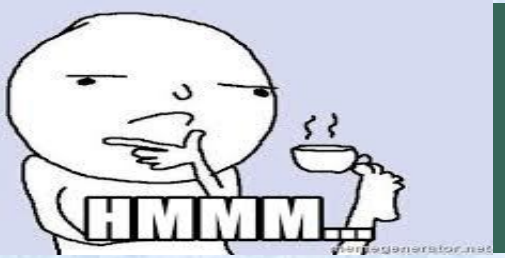
RECAP

T/F QUIZ: DO YOU RMB?



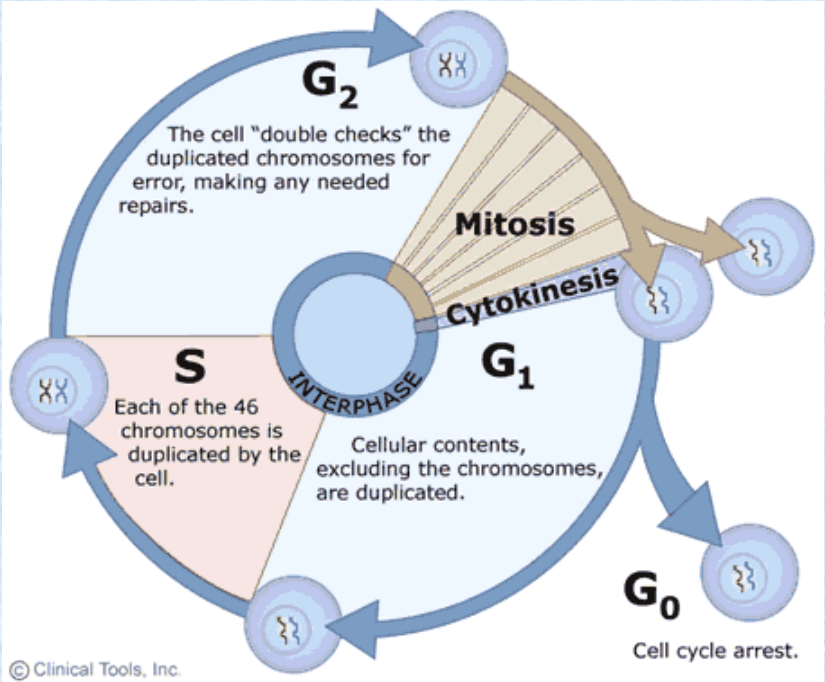
	T	F
1) Interphase is part of the cell cycle		

Cell Cycle = Interphase + Cell Division

RECAP

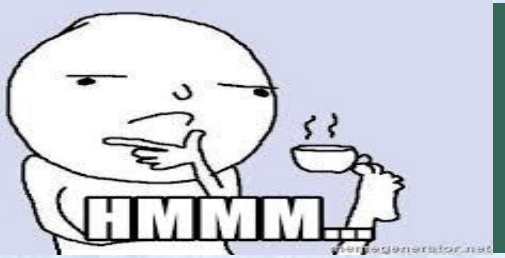
T/F QUIZ: DO YOU RMB?

	T	F
2) Sequence in interphase: G1 → G2 → S		



RECAP

T/F QUIZ: DO YOU RMB?



	T	F
3) Cytokinesis is NOT part of Mitosis & Meiosis		

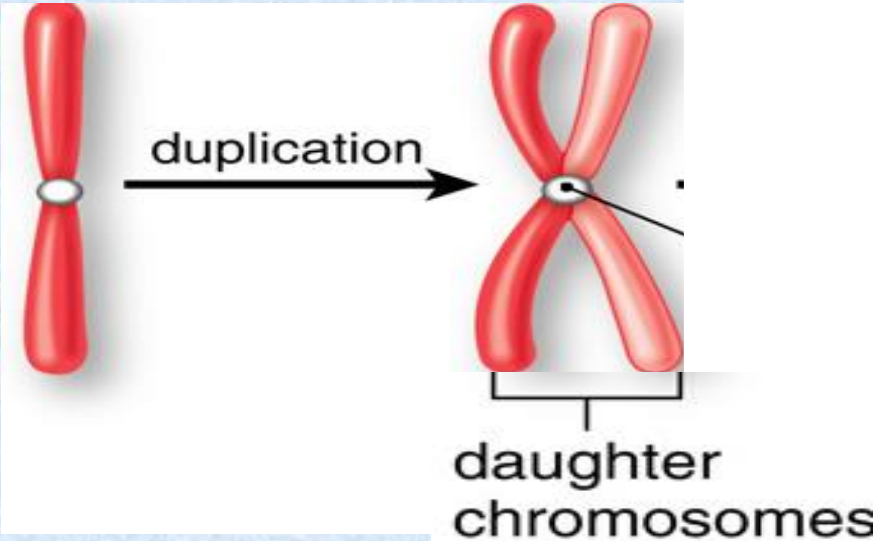
Mitosis / Meiosis

Cell Division = Nuclear division + Cytoplasmic Division

RECAP

T/F QUIZ: DO YOU RMB?

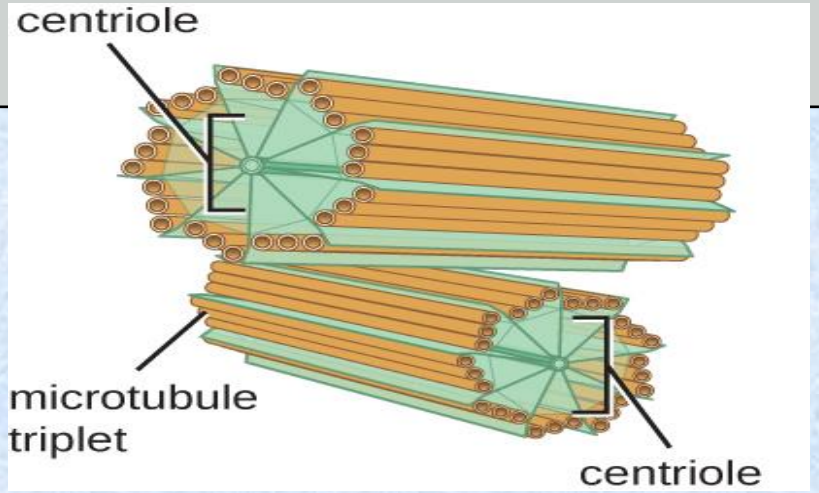
	T	F
4) After S-phase, 2 daughter chromosomes are joined at the centromere.		



RECAP

T/F QUIZ: DO YOU RMB?

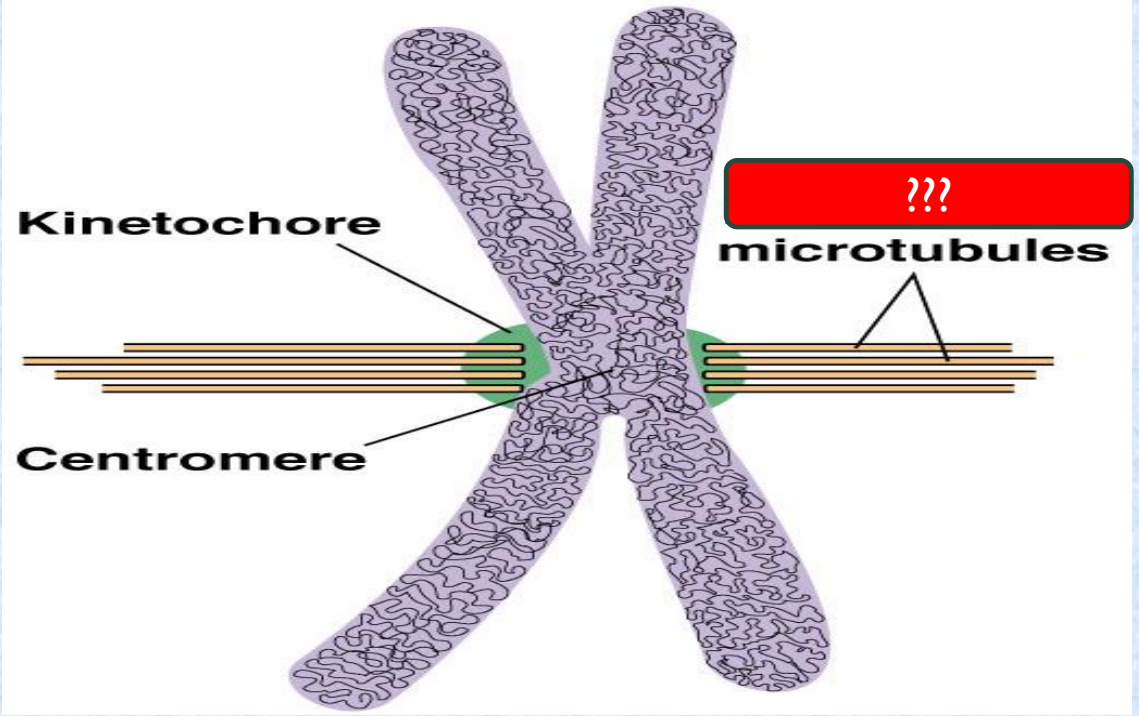
	T	F
5) All of the following are made of **DNA**: **C**hromatin; **C**hromosomes; (duplicated) **C**hromosomes; **C**hromatids ; **C**entrioles; **C**entromeres		



RECAP

T/F QUIZ: DO YOU RMB?

	T	F
6) ??? = Kinetochore microtubules		



OUTLINE OF MY LECTURES

1. **Introduction to cell cycle**

2. **Mitosis & its Significance**

3. **Meiosis & its Significance**

MITOSIS

Lecture Book 4
Pg 10

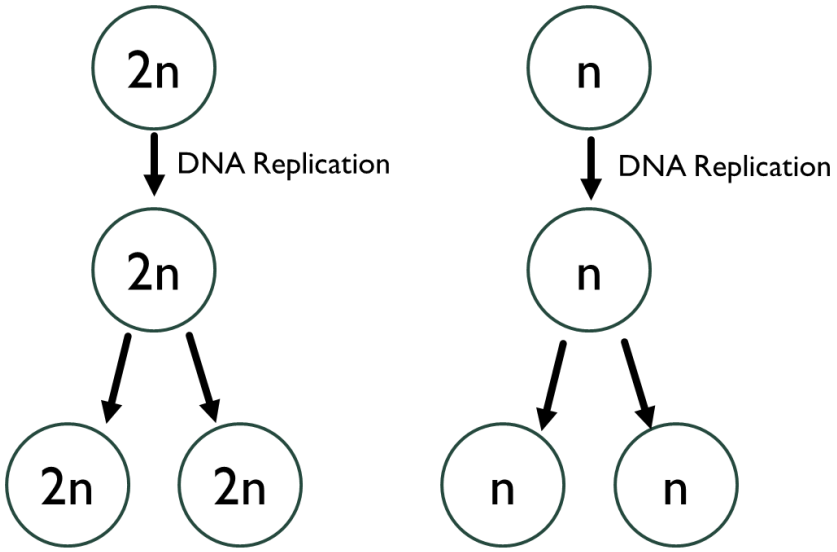
LEARNING OBJECTIVES

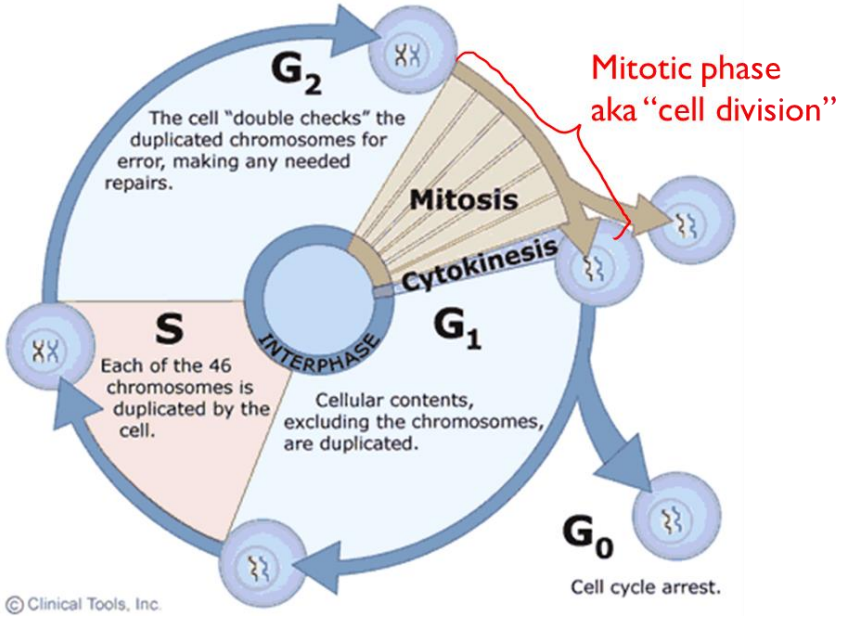
(f) describe the events that occur during the mitotic cell cycle and the main stages of mitosis (including the behaviour of chromosomes, nuclear envelope, cell surface membrane and centrioles)

(g) explain the significance of the mitotic cell cycle (including growth, repair and asexual reproduction) and the need to regulate it tightly (knowledge that dysregulation of checkpoints of cell division can result in uncontrolled cell division and cancer is required, but details of the mechanism are not required)

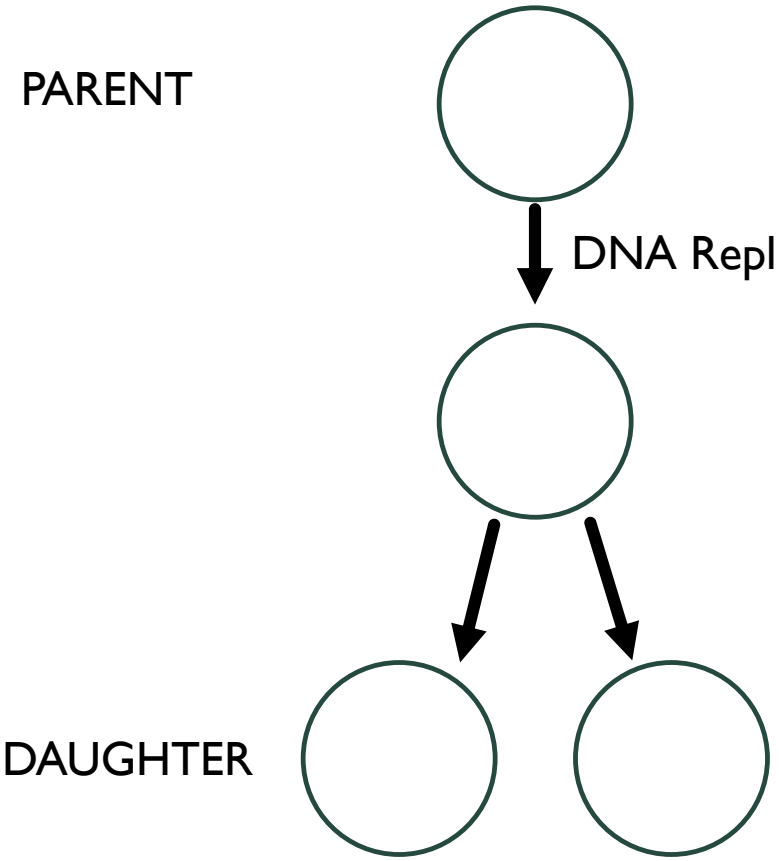
INTRODUCTION

- Mitosis is a type of nuclear division and the mitotic cell cycle produces **two daughter nuclei** that are **genetically identical** to the parent cell.
- **Haploid** and **diploid** cells can undergo **the mitotic cell cycle**

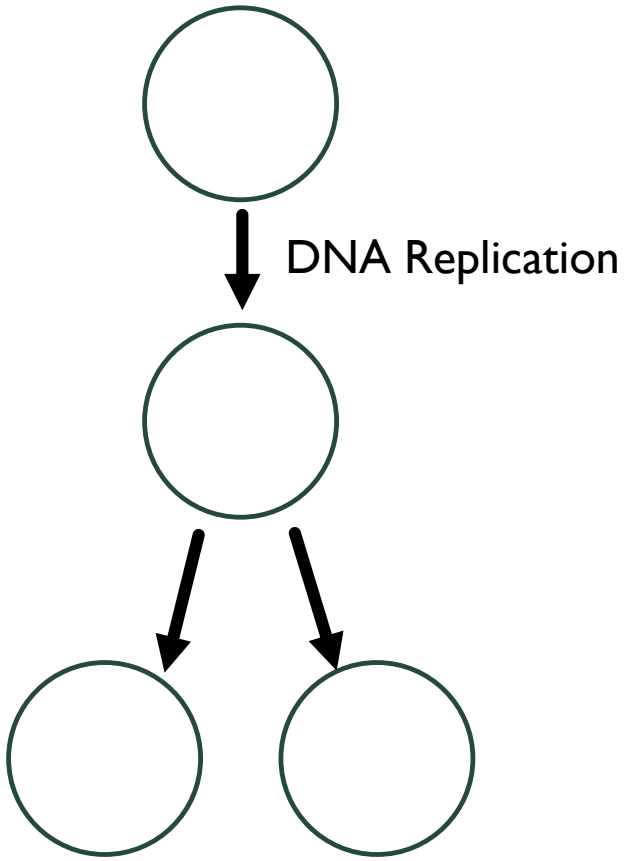




MITOSIS



MITOSIS



- if the parent cell is ***diploid*** (2n), the daughter cells will also be ***diploid*** (2n).
- if the parent cell is ***haploid*** (n), then the daughter cells will be ***haploid*** (n).

Not in notes

Ploidy: **Number of sets** of chromosomes in the cell

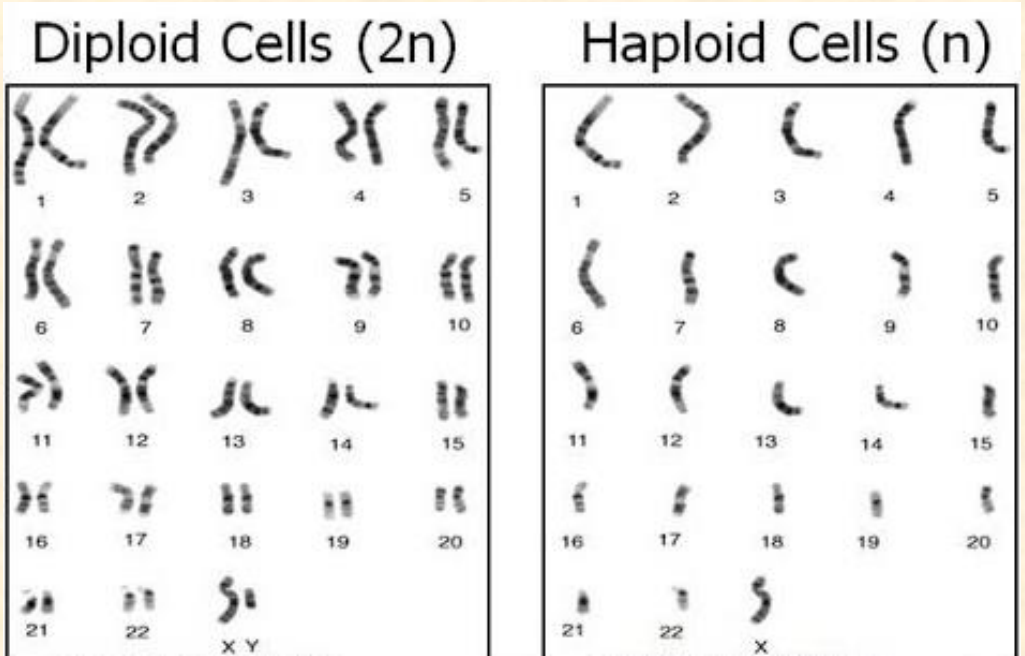
Diploid – **2** sets of chromosomes (2n)

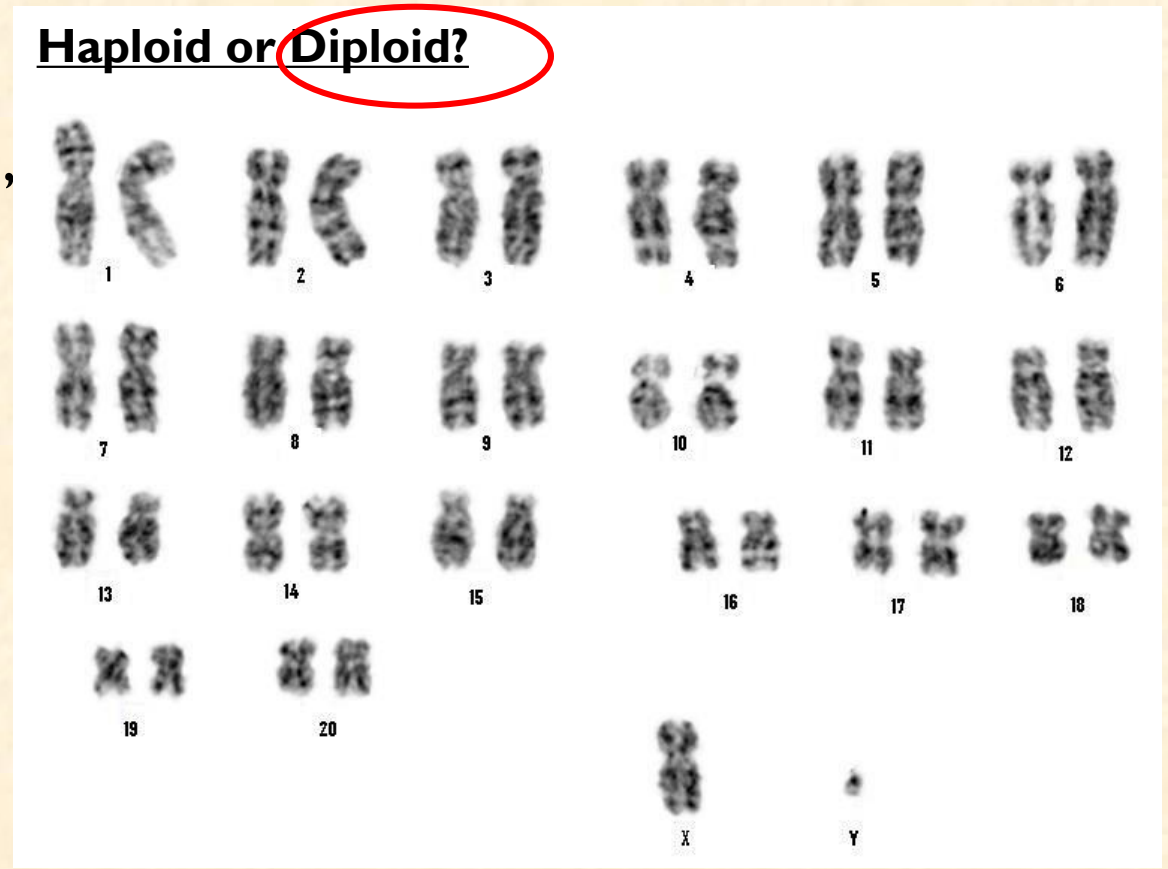
Haploid – **1** set of chromosome (n)

✓"A diploid cell"

✓"Cell is in a diploid condition"

X "A cell has a diploid number of chromosomes"



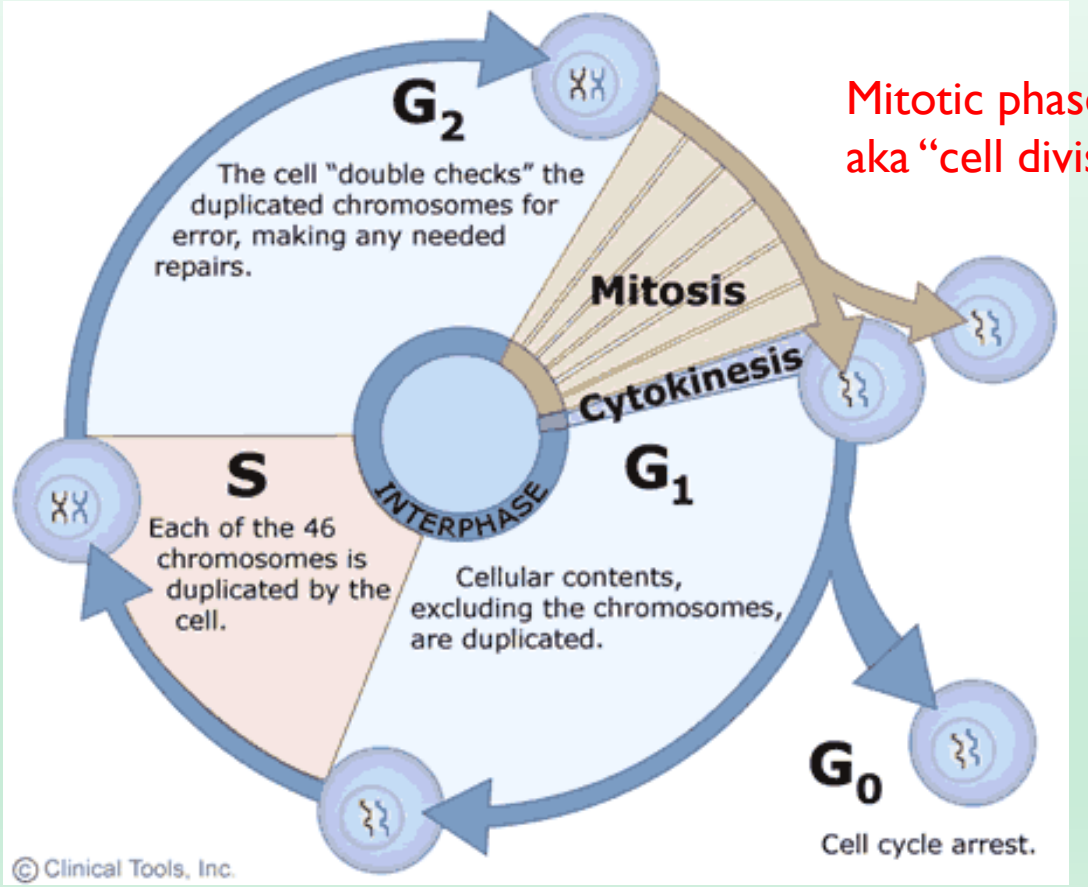


RECAP

MITOTIC CELL CYCLE OVERVIEW

Mitotic cell cycle is divided into:

1. Interphase (G1, S & G2 phase)
2. Cell division phase comprises of:
   a. Mitosis* (nuclear division)
   b. Cytokinesis (division of cytoplasm)

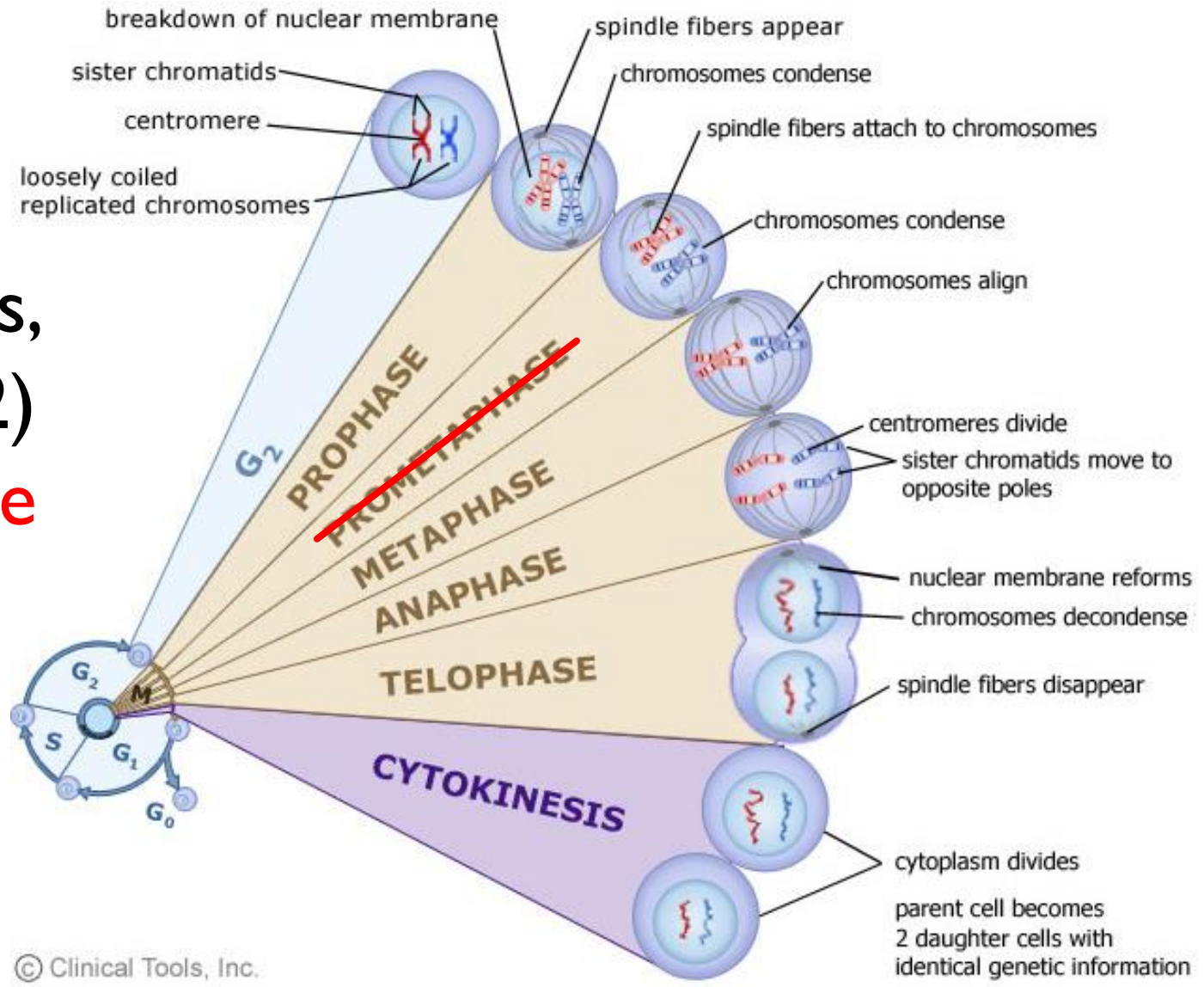


Mitotic phase
aka "cell division"

NOT IN NOTES

Nuclear Division:

Mitosis has 4 phases, namely (1) **P**rophase, (2) **M**etaphase, (3) **A**naphase and (4) **T**elophase.

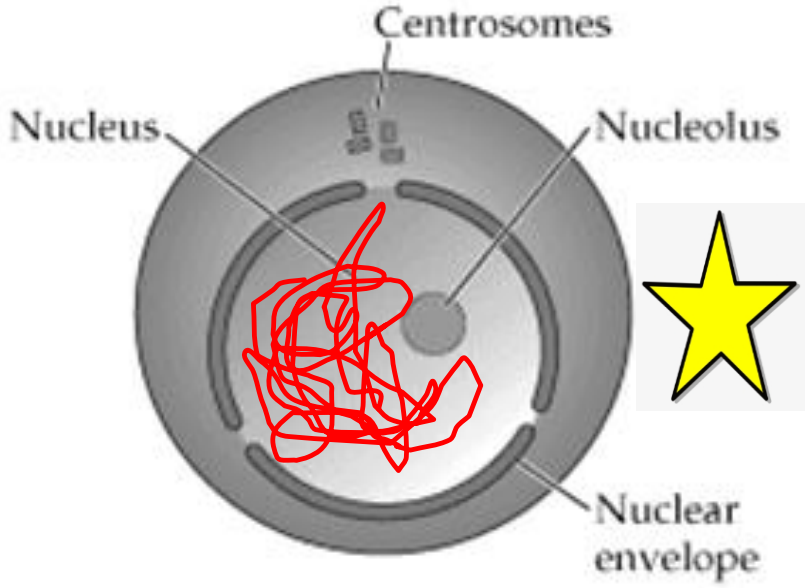


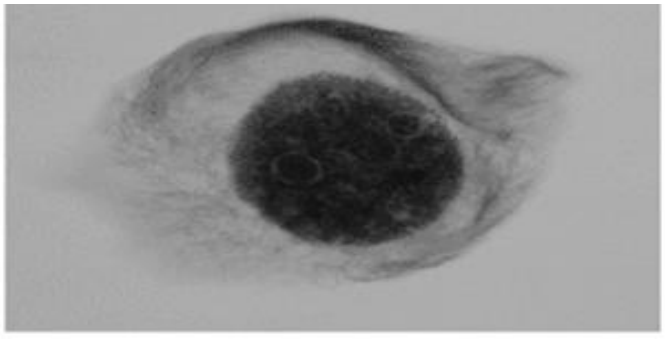
NOTES ORGANISATION FORMAT [MITOSIS & MEIOSIS]

~~PHASE	
Behaviour of:	Description
Chromosomes	
Nuclear envelope	
Centrioles & centrosomes	
Cell surface membrane	

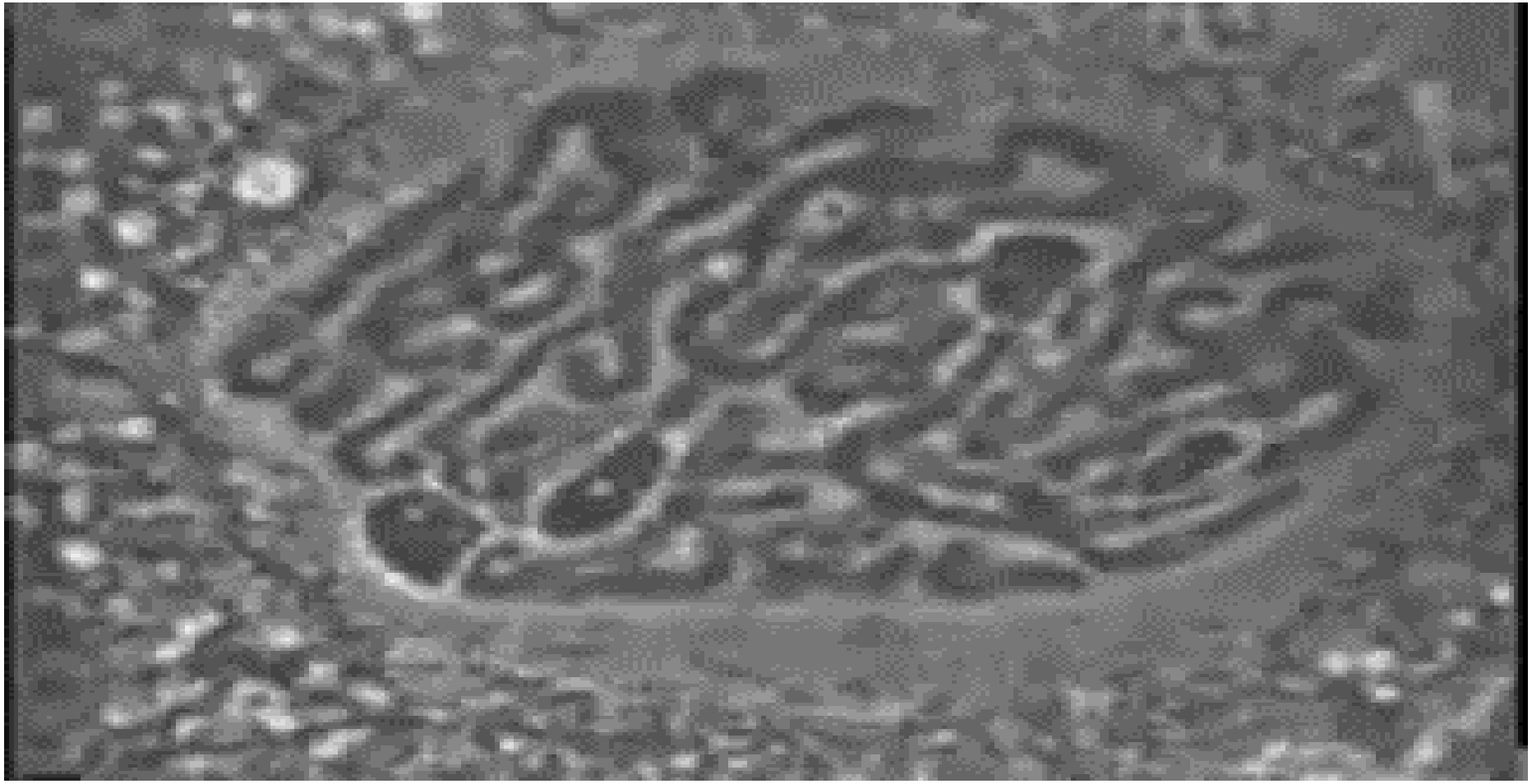
INTERPHASE

- DNA in nucleus exists as **long thin chromatin fibres.**
- During **S phase** of interphase, **DNA replication** occurs.
- The single **centrosome** (with its pair of **centrioles**) **duplicates**, forming two centrosomes (each with a pair of centrioles) which remain together near the nucleus.



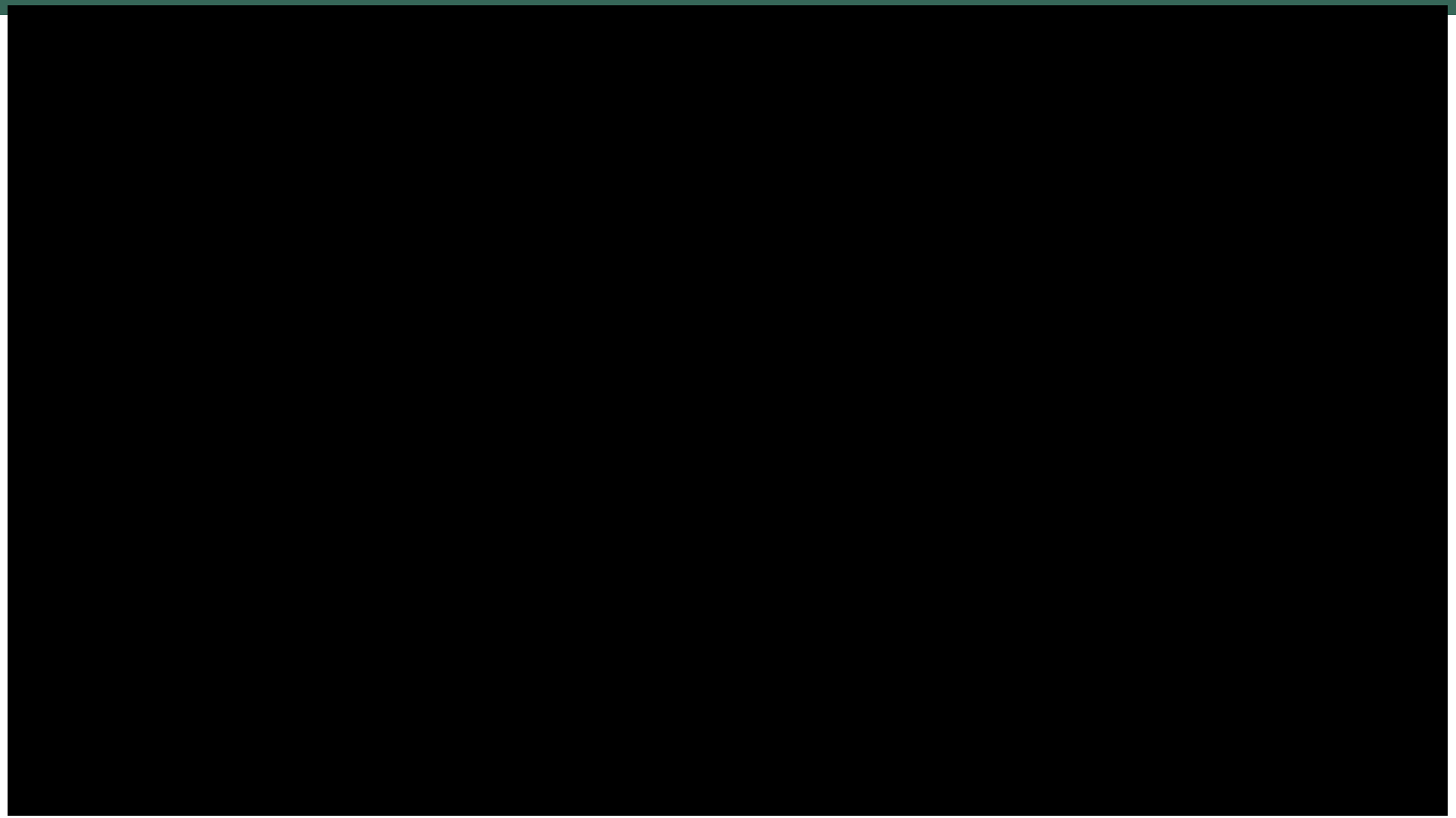


MITOSIS IN REAL LIFE (TIME LAPSE)



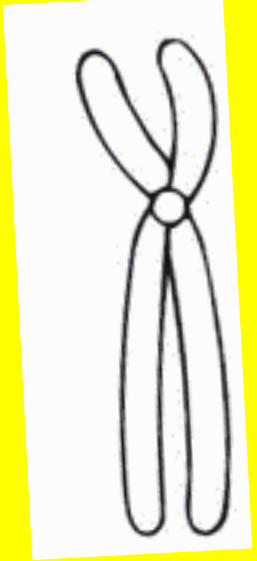
https://www.youtube.com/watch?v=l21p3gsECGM

CATCHY MITOSIS SONG: HTTPS://WWW.YOUTUBE.COM/WATCH?V=ZGAJOO7CCL8



A) PROPHASE

Said the cell, "I'm not feeling quite right;"
My chromatins' wound really tight;
Both centrioles,
Are at opposite poles,
And my envelopes' fading from sight!



A

Duplicated chromosome:

2 identical sister chromatids held together by centromere

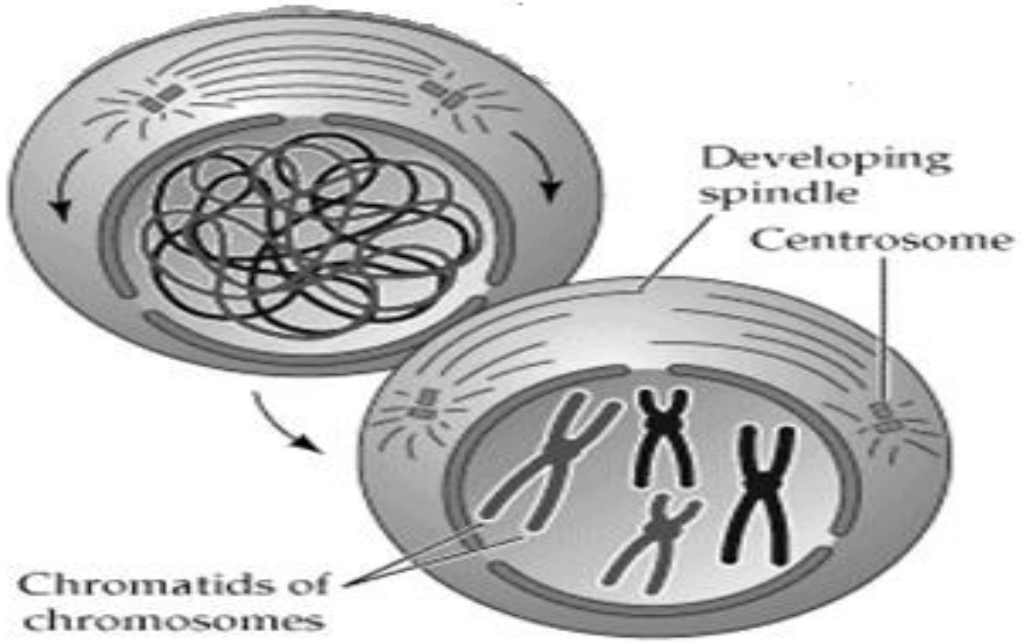
or

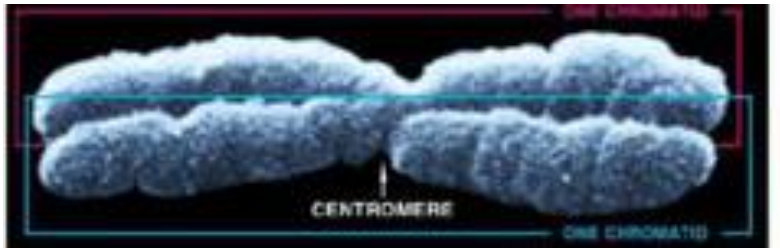
B

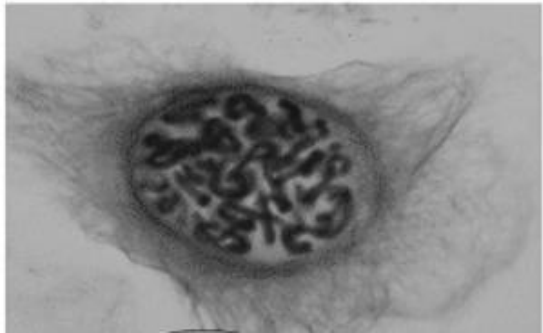
Unduplicated chromosome

A) PROPHASE

- Chromatin **shorten and thicken by coiling** to form chromosome structure called ***duplicated chromosome*** and tighter packaging of their components ;
- Each duplicated chromosome consists of **two genetically identical sister *chromatids*** held together by a ***centromere***;

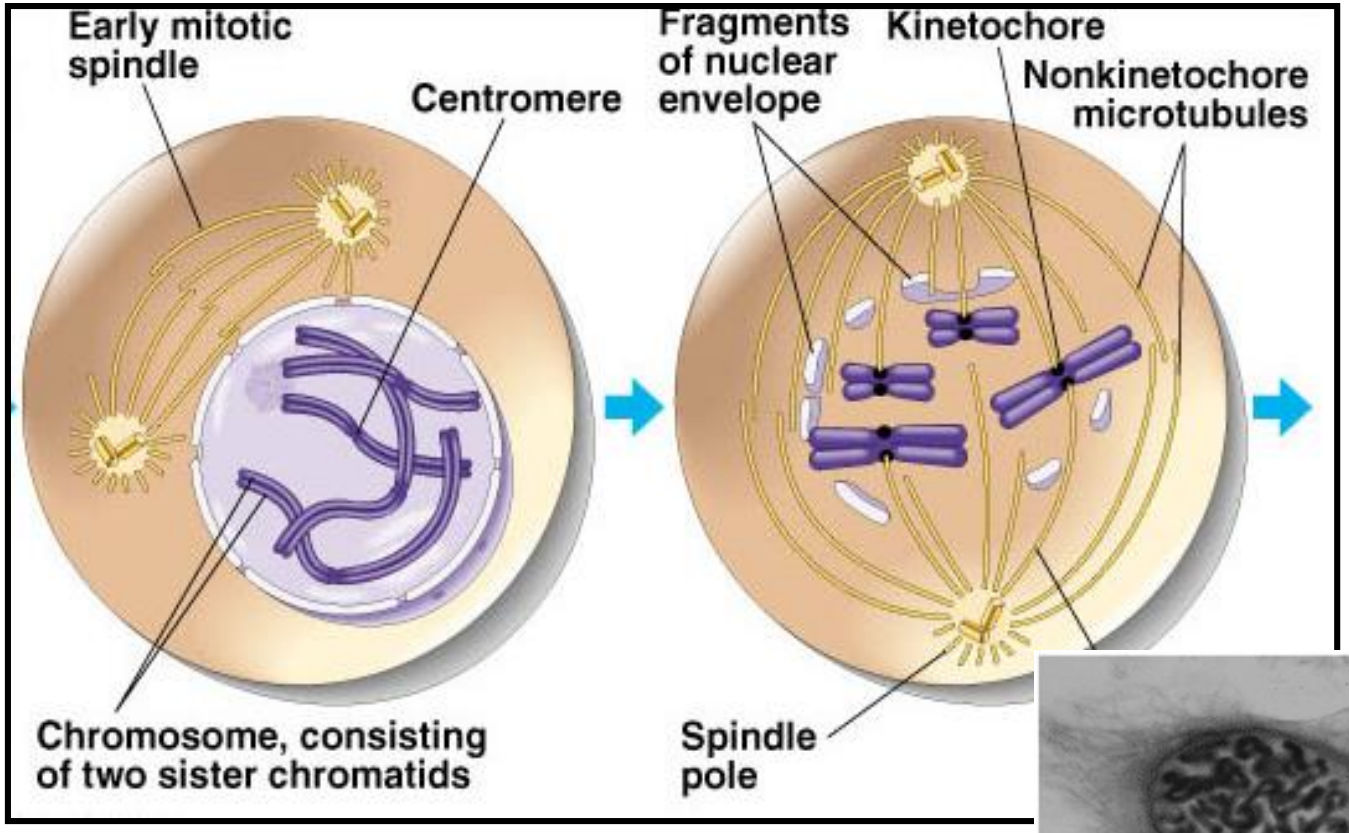


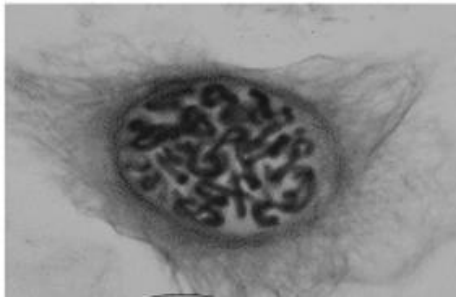




A) PROPHASE

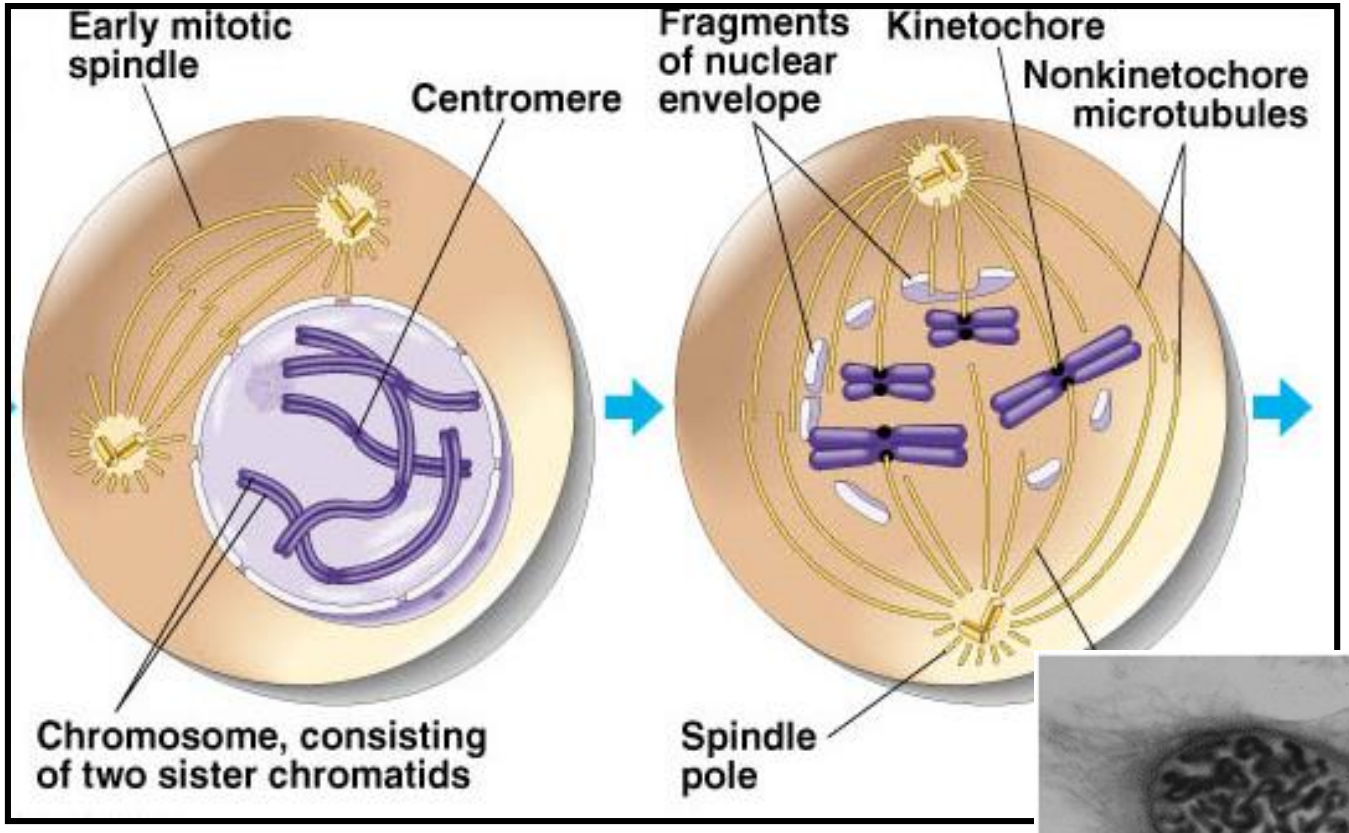
- Nucleoli disappear;
- Nuclear envelope starts to **fragment** and disappear. **[WHY???]**
- This **allows *spindle fibres*** **to attach to chromosomes** and to allow the **free movement** of **chromosomes** to the metaphase plate;

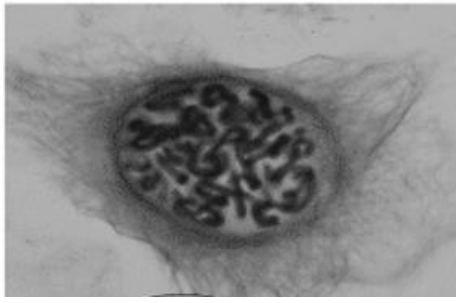




A) PROPHASE

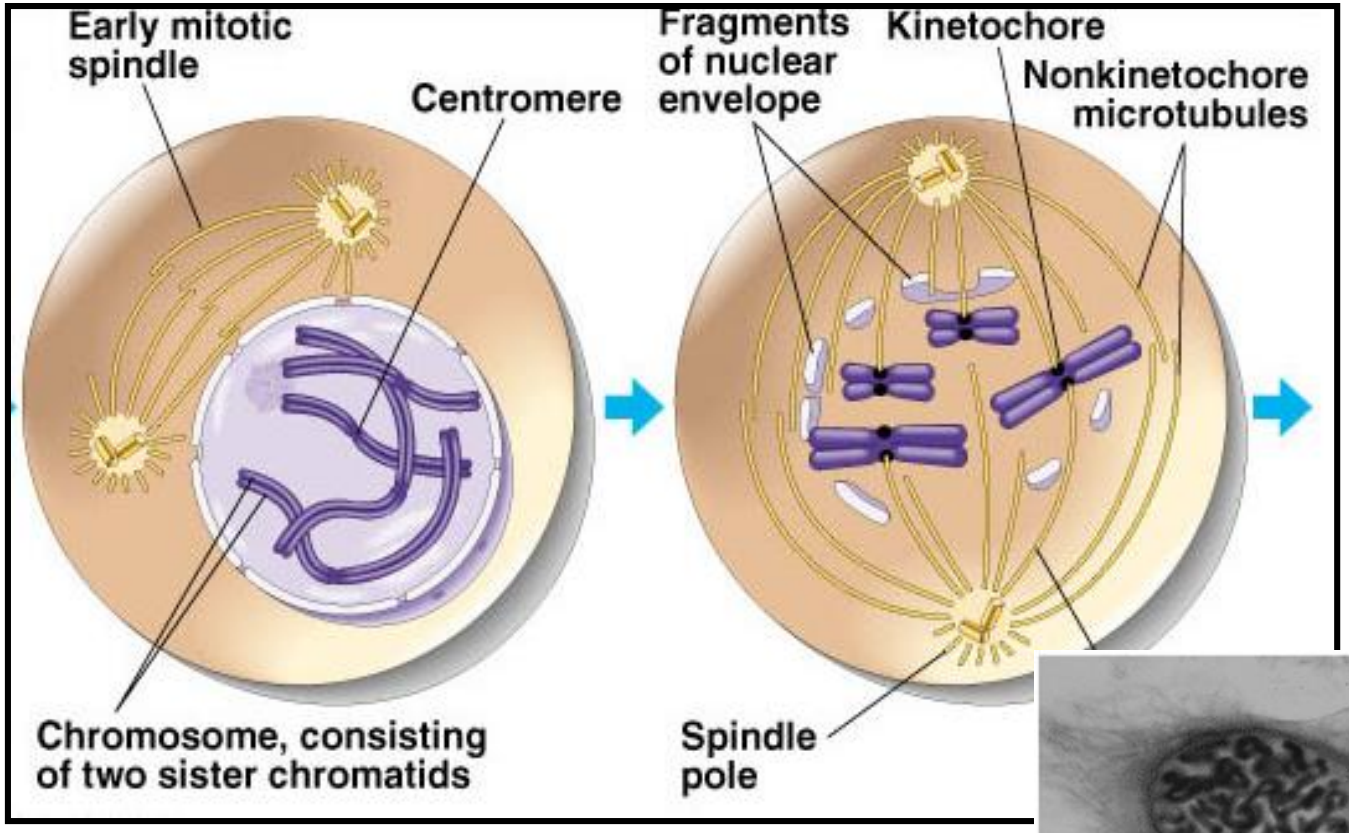
- *Centrosome* & their pair of *Centrioles* move to **opposite poles** of cell to **determine polarity of cells**
- The two centrosomes move apart as spindle microtubules grow out from them;

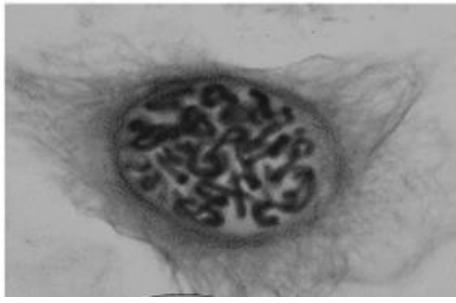




A) PROPHASE

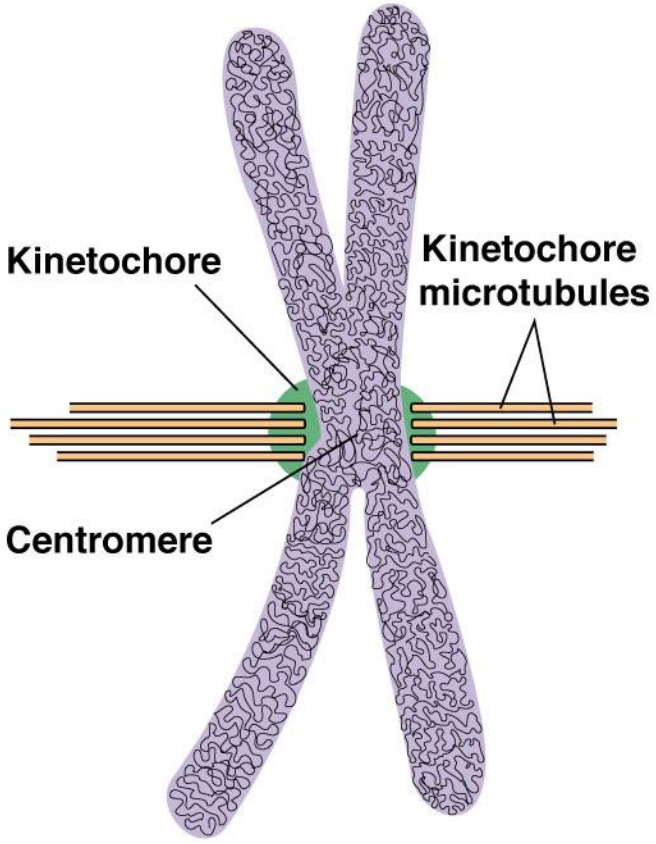
- **Polar** microtubules extend from each centrosome toward the middle of the cell; Polar microtubules from opposite ends contact with each other
- Asters/astral MTs are the radial arrays of shorter microtubules that extend from the centrosome;

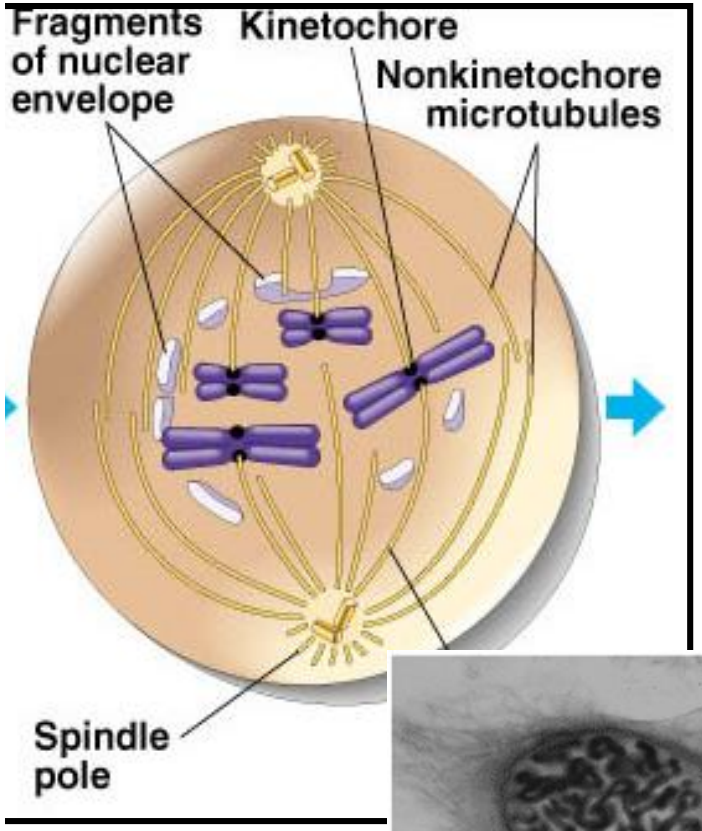


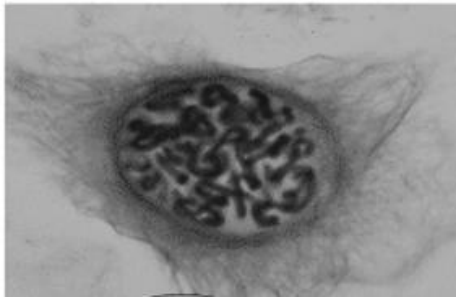


A) PROPHASE

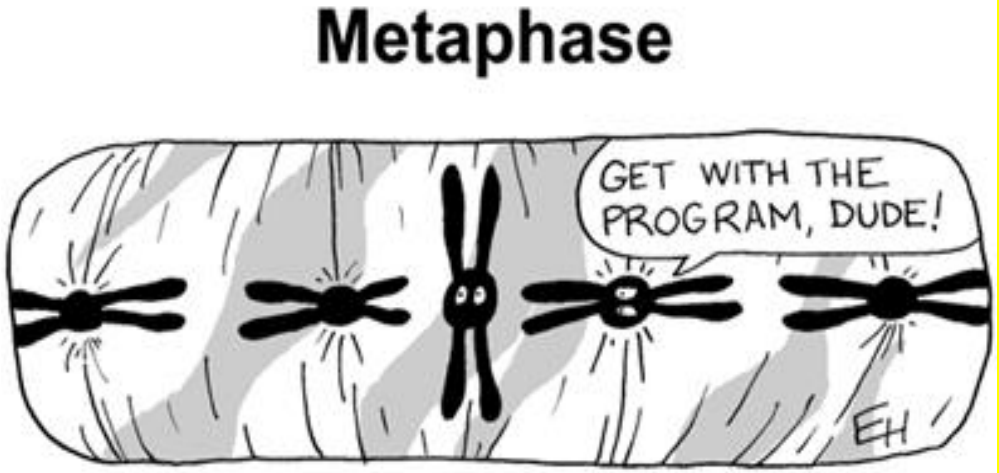
- Each of the sister chromatids of a duplicated chromosome now has a kinetochore **(protein complex)** assembled on the centromere ;
- Kinetochore microtubules attach to the kinetochore of duplicated chromosomes;



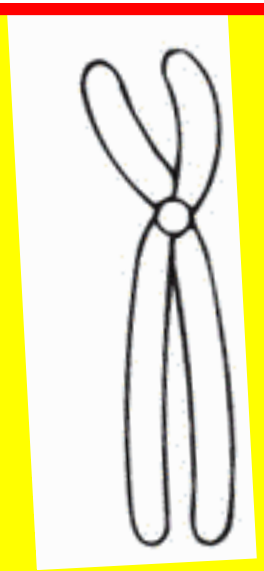




B) METAPHASE



With kinetochores starting to grow,
The chromosomes all in a row,
Are tidy and straight,
On the metaphase plate,
With a spindle above and below.



A

Duplicated chromosome:

2 identical sister chromatids held together by centromere

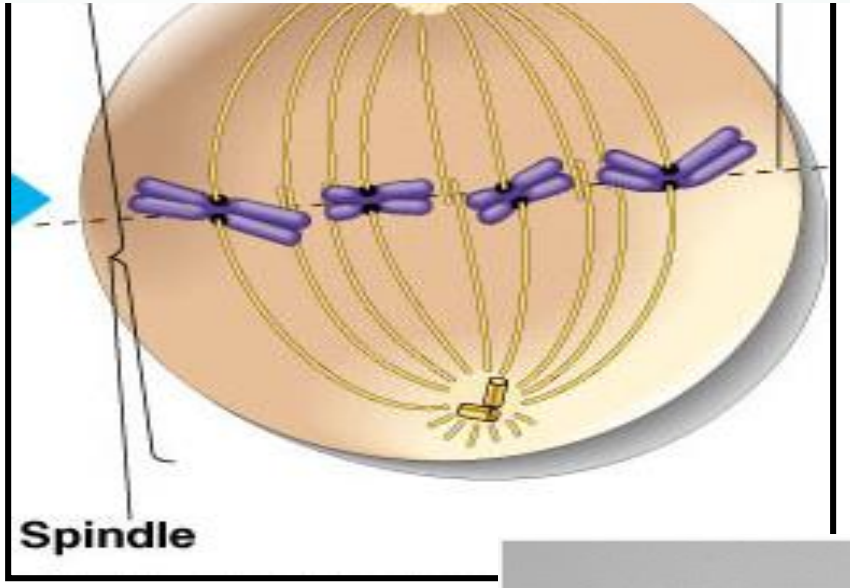
or

B

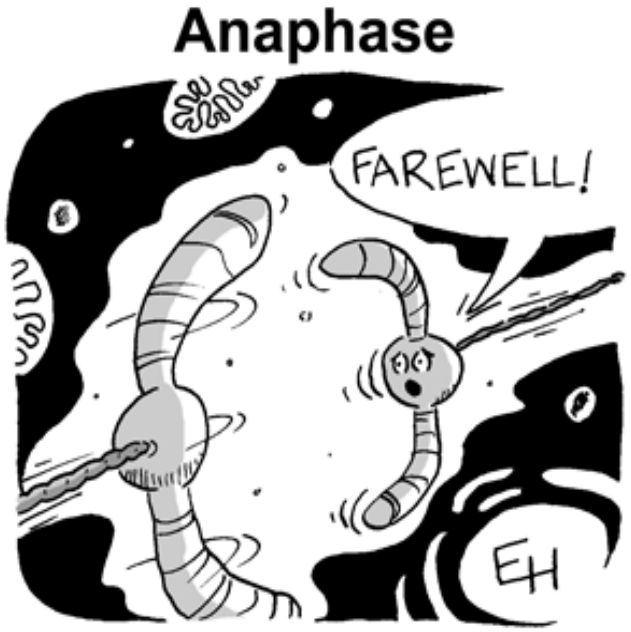
Unduplicated chromosome

B) METAPHASE

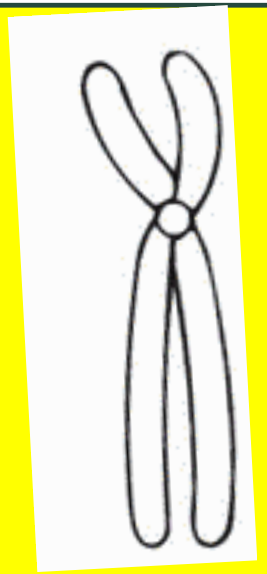
- The centrosomes are now at **opposite poles** of the cell;
- Duplicated chromosomes are pulled to the **metaphase plate**;
- Duplicated chromosomes line up **SINGLY** (**in a 'single file')** along the metaphase plate;
- For each duplicated chromosome, the **kinetochores** on the sister chromatids are **attached to kinetochore microtubules** coming from opposite poles;



C) ANAPHASE



A chomosome shaking with dread,
To her dear sister chromatid said,
"Though it's beaking my heart,
We'll be soon torn apart,
By a strong microtubule thread!"



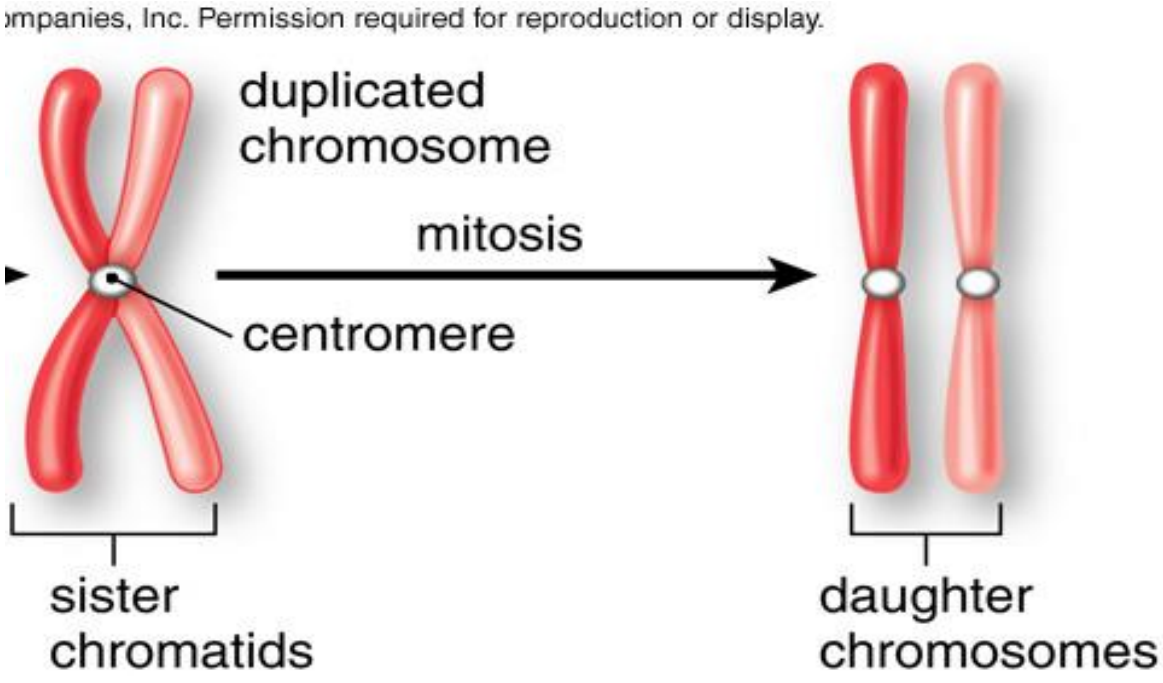
A or B

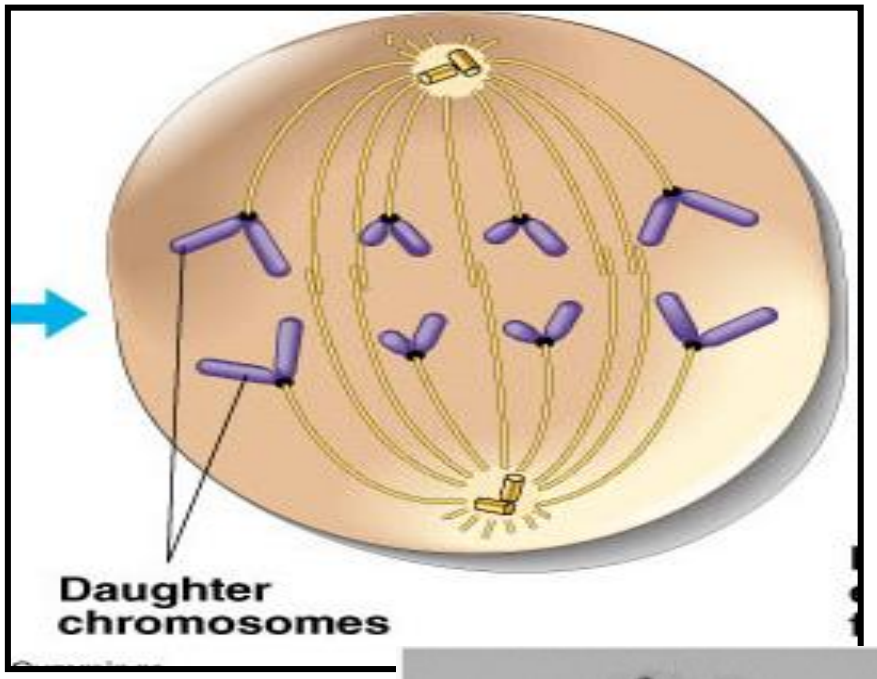
Duplicated chromosome:
2 identical sister chromatids held together by centromere

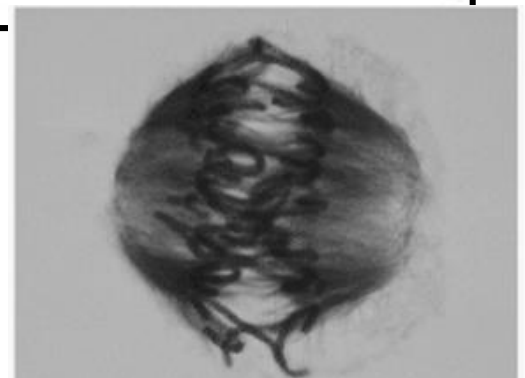
Unduplicated chromosome

C) ANAPHASE

- **<u>Centromeres divide</u>**;
- Sister chromatids separate to form individual **daughter chromosomes**;

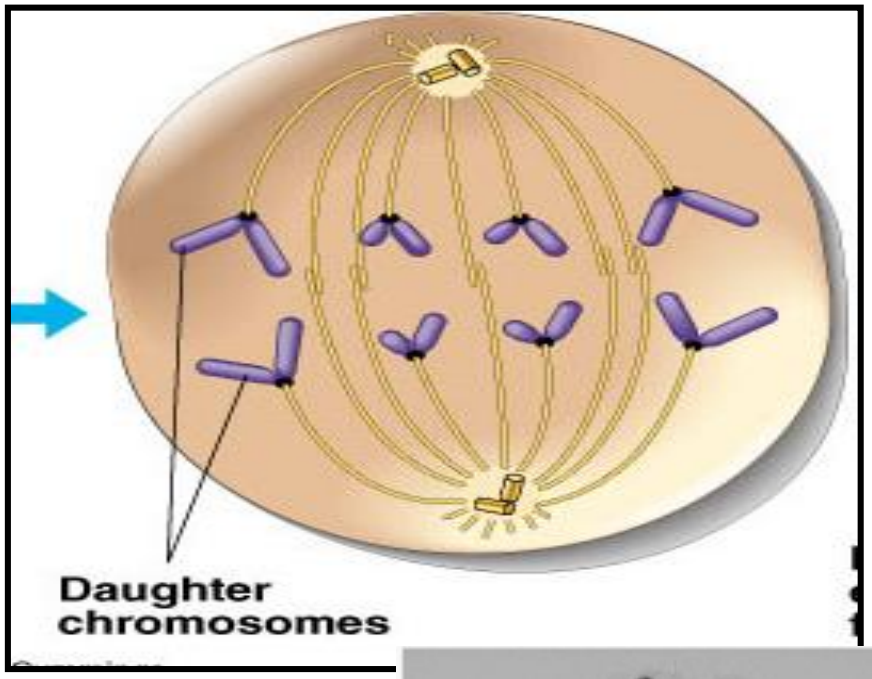


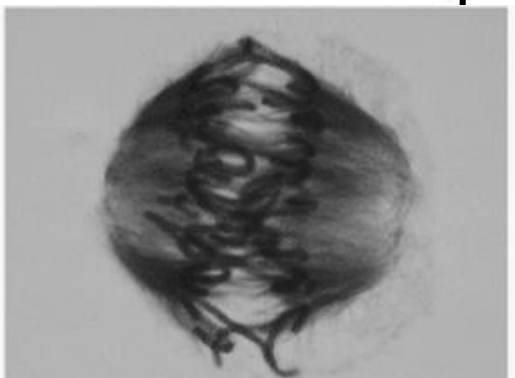




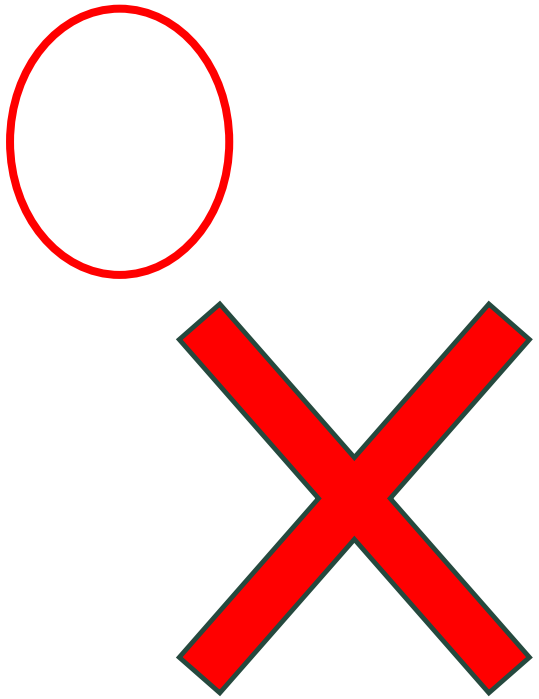
C) ANAPHASE

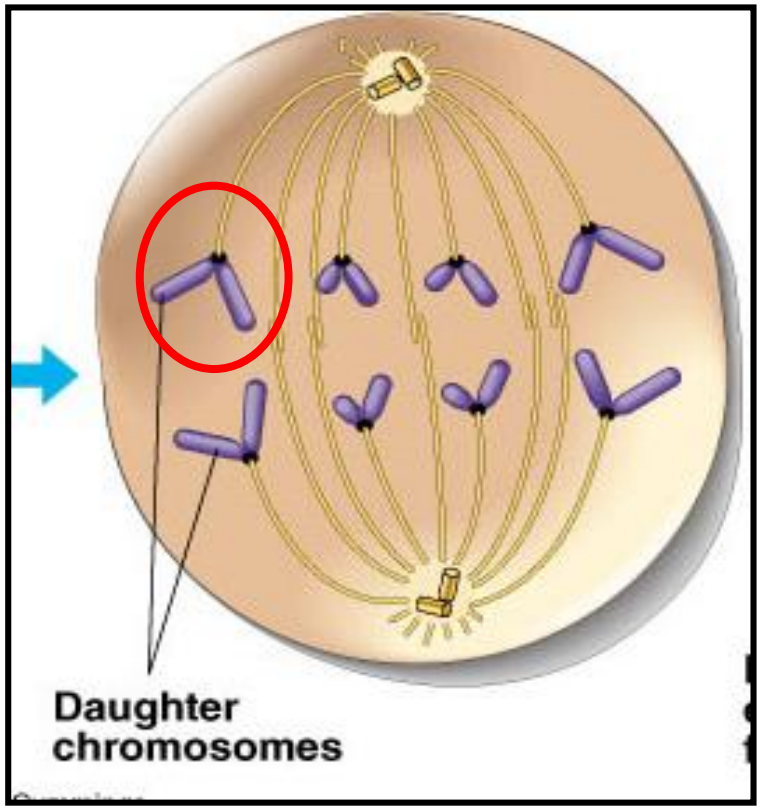
- Chromosomes are pulled apart **to opposite poles of the cell** by *the shortening of* kinetochore microtubules;
- Separated chromatids / **chromosomes** are **pulled along <u>behind</u> centromeres** because kinetochore microtubules are attached to the centromeres;





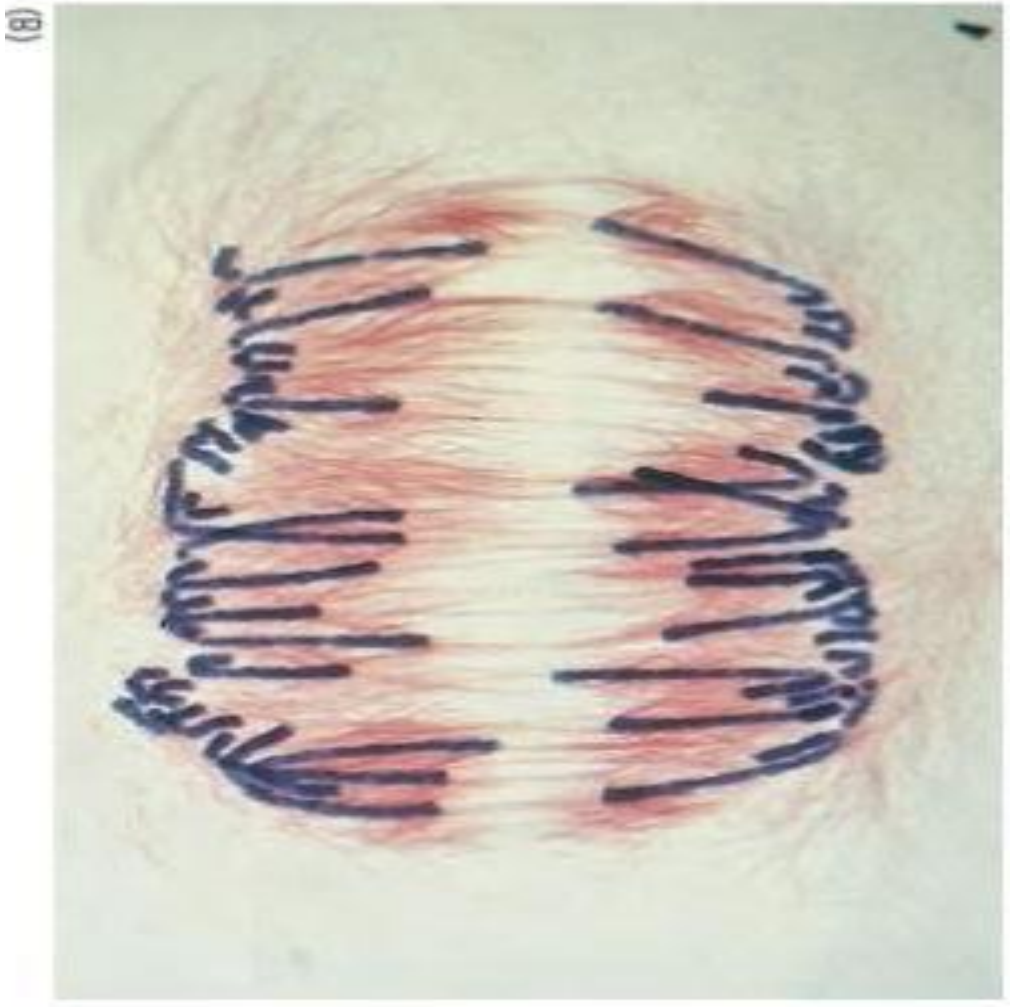
C) ANAPHASE





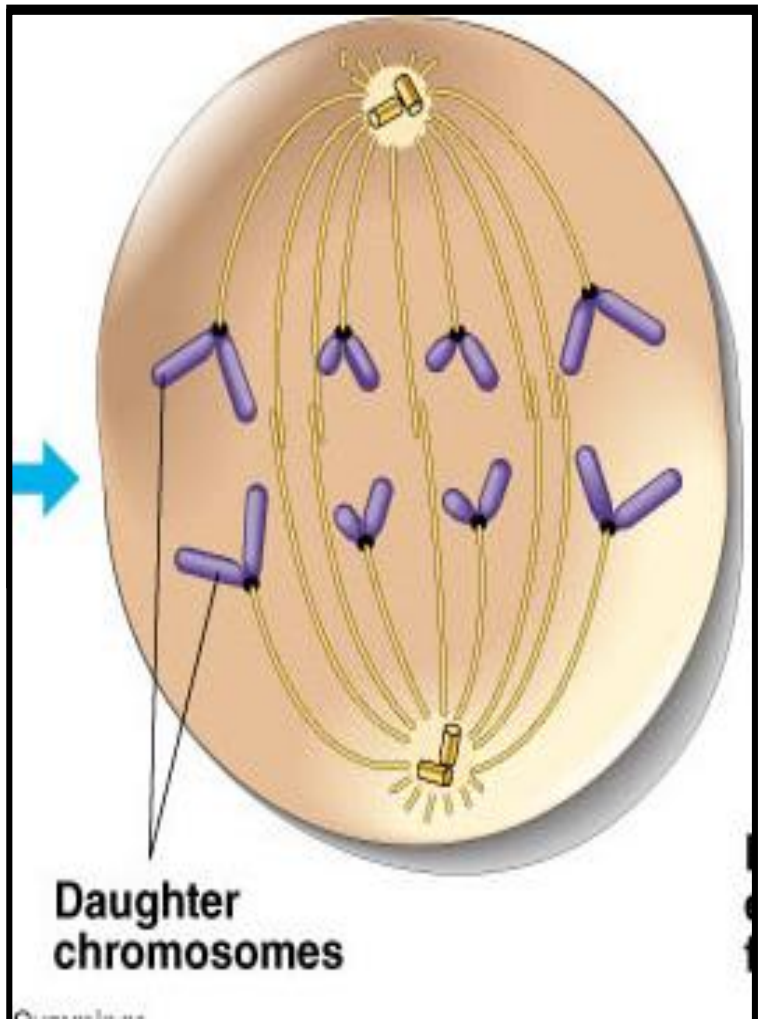
NOT IN NOTES

Centromere location	Designation	Metaphase shape	Anaphase shape
Middle	Metacentric	Sister chromatids, Centromere	Migration
Between middle and end	Submetacentric	p arm, q arm	
Close to end	Acrocentric		
At end	Telocentric		

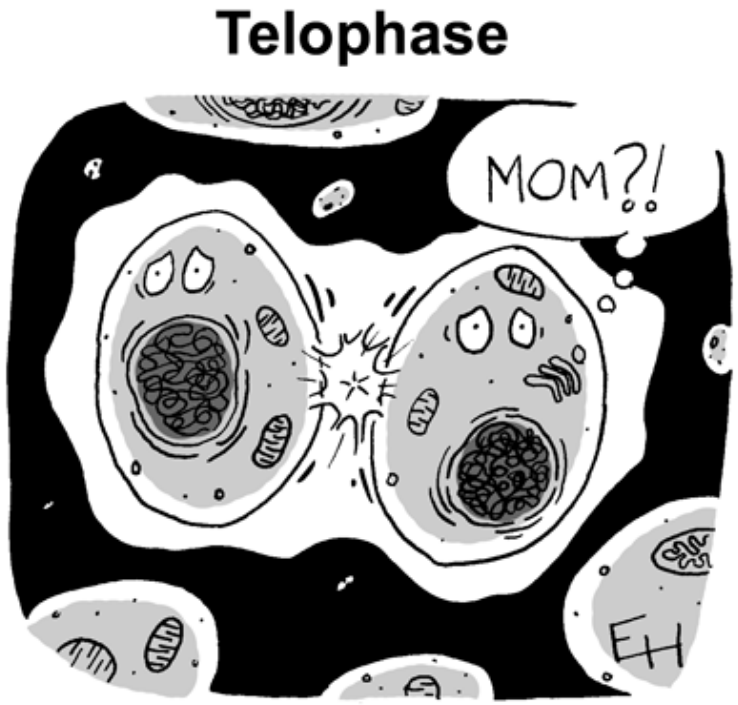


C) ANAPHASE

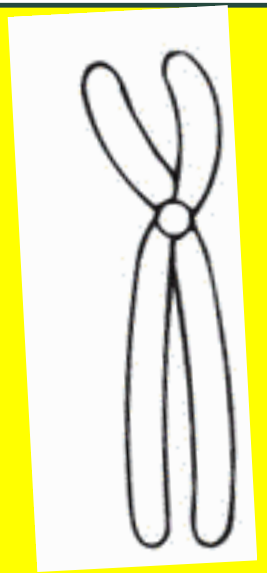
- The cell **elongates** as the polar microtubules **lengthen**;
- By the end of anaphase, the two poles of the cell have **equivalent** and **complete collection (2n)** of chromosomes;



D) TELOPHASE



The daughter cells said, "We admit,
To being confused just a bit;
We've no father or brother,
And it seems that our mother,
Has quite unexpectedly split!"



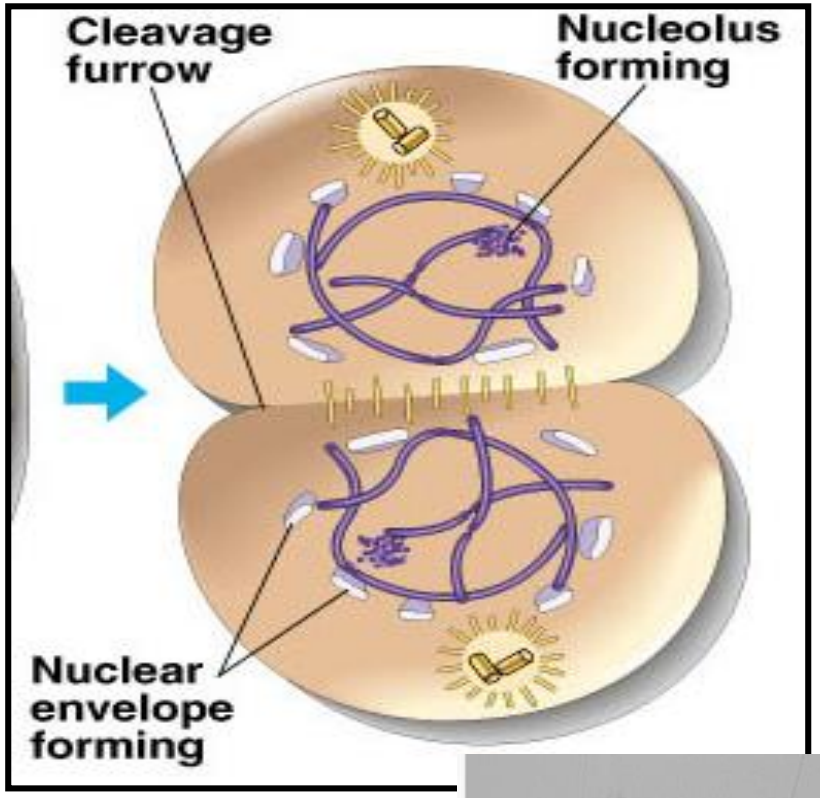
A or B

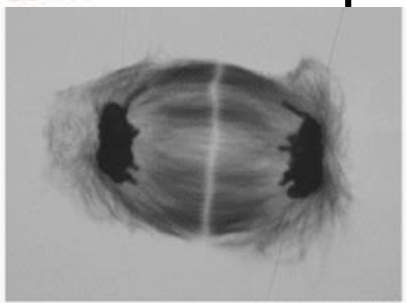
Duplicated chromosome:
2 identical sister chromatids held together by centromere

Unduplicated chromosome

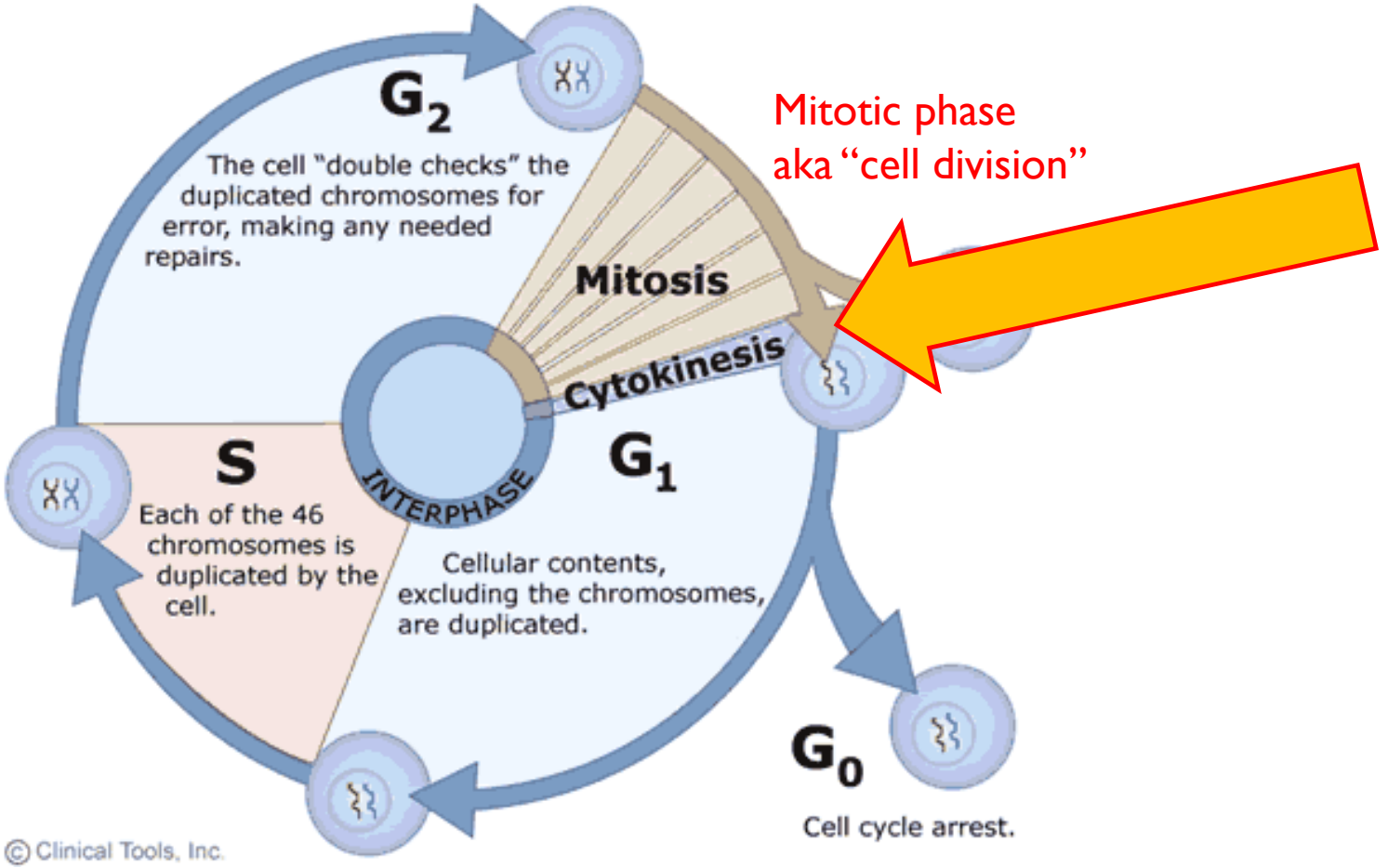
D) TELOPHASE

- Chromosomes <u>reach</u> **opposite poles** of the cell, **uncoil and lengthen** to form **chromatin** again;
- Spindle fibres depolymerized and disintegrate;
- **Nuclear envelope re-forms** around the chromosomes at each pole. **[WHY???]**
- Nucleoli reappear.





MITOTIC CELL CYCLE



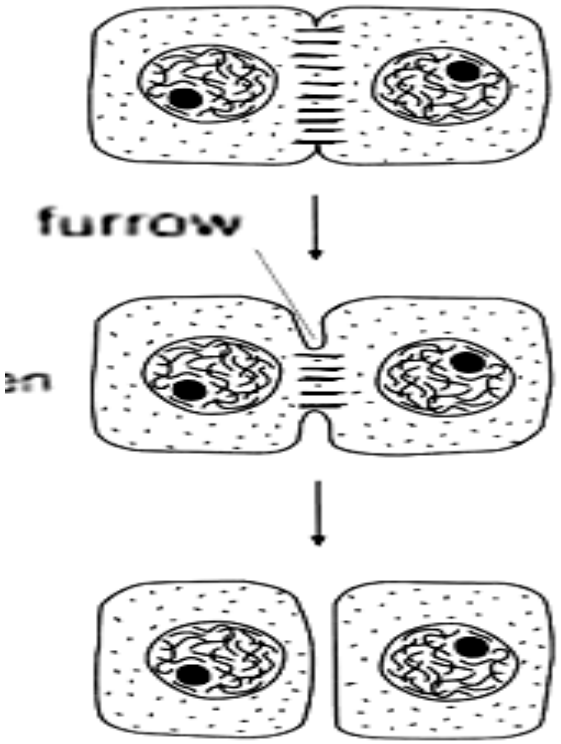
Mitotic phase
aka "cell division"

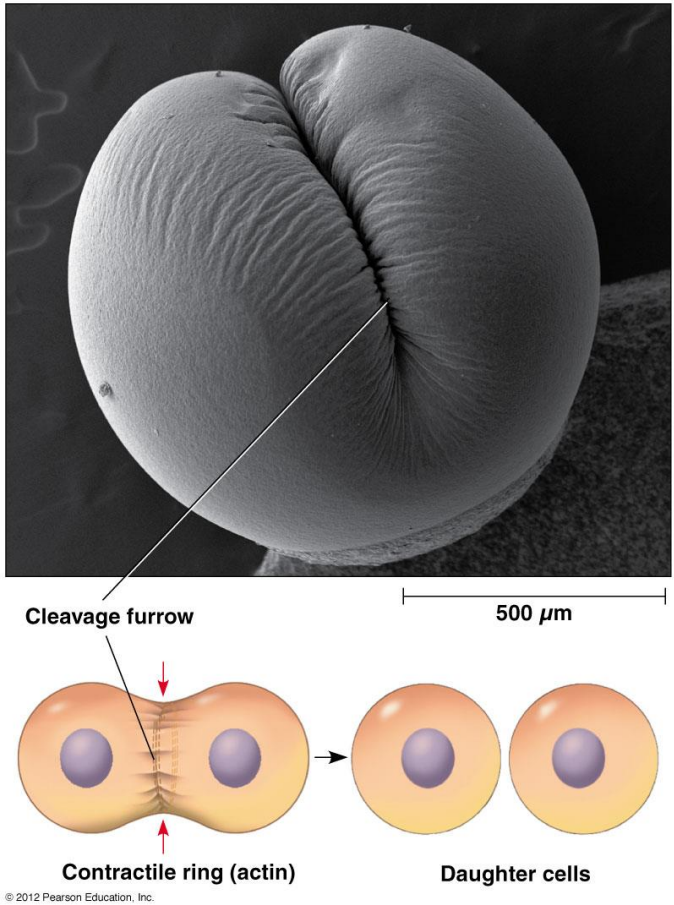
CYTOKINESIS

- Division of the **cytoplasm** via **cleavage of cell surface membrane** in animal cell or via **cell plate formation** in plant cell to form 2 daughter **cells**.

CYTOKINESIS: ANIMAL CELL

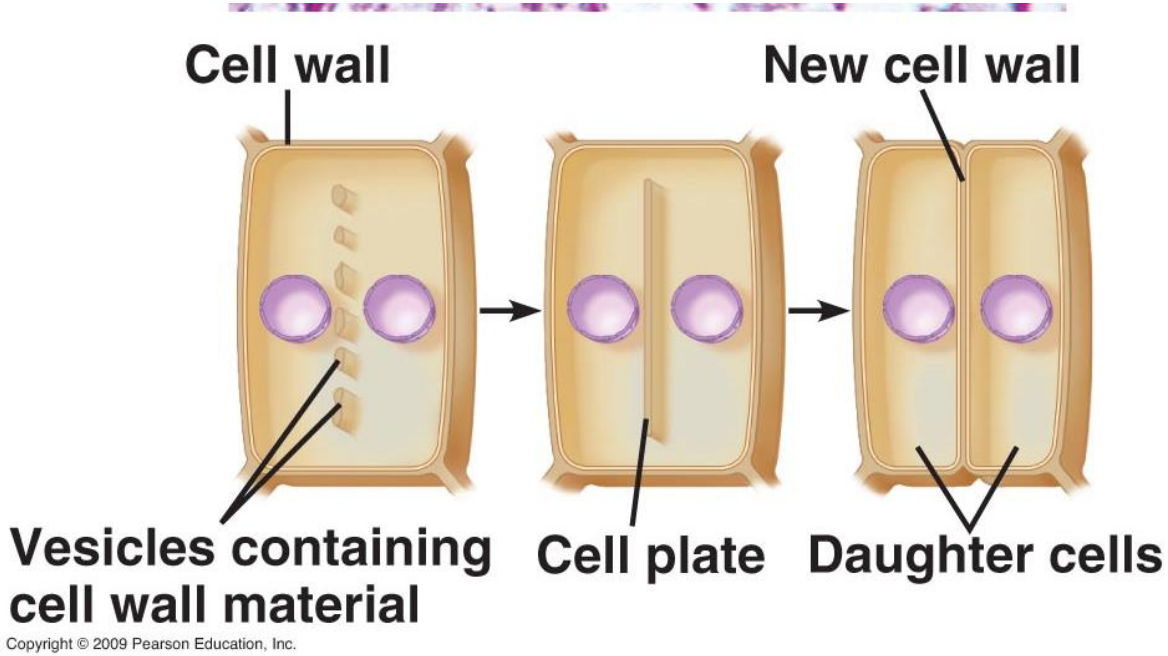
1. Via **cleavage** of <u>cell surface membrane</u>;
2. **Cleavage furrow** develops in the cell membrane;
3. The furrow then **deepens** until it completely pinches off & **separates** the two daughter cells.

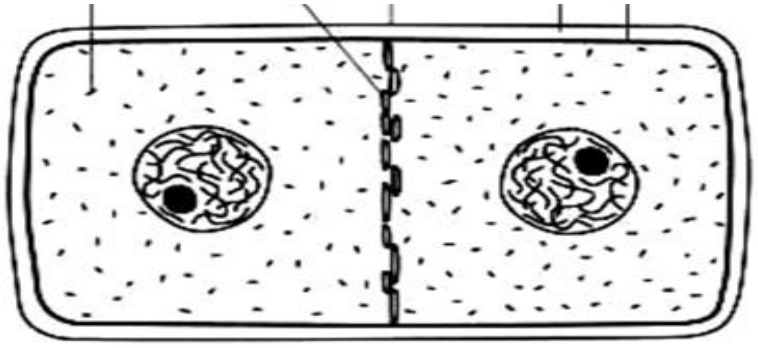




CYTOKINESIS: PLANT CELL

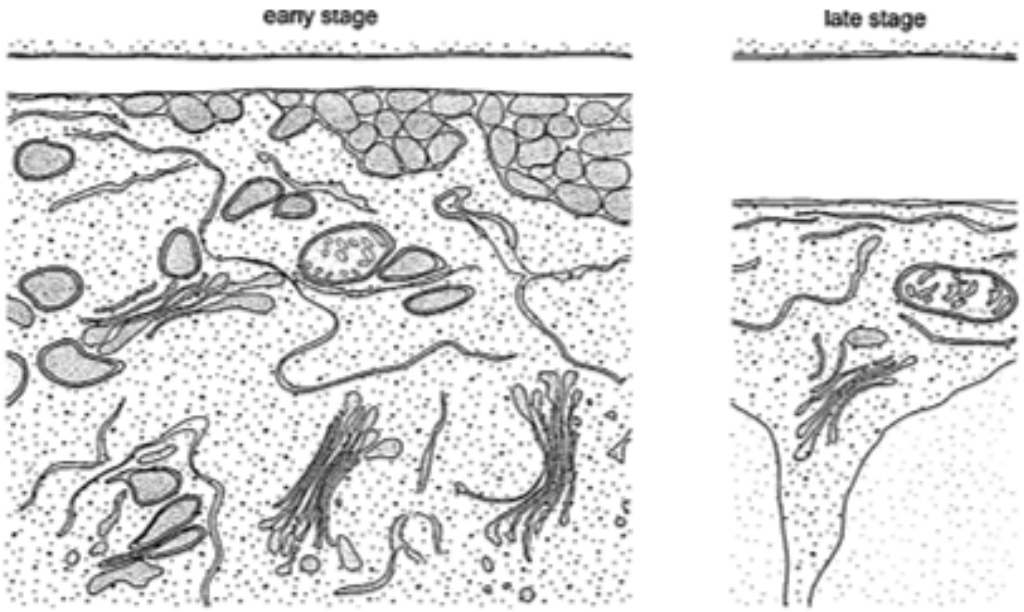
- Via cell plate formation ;
- Golgi vesicles move along microtubules to the **equator** of the parent cell ;
- Vesicles fuse to form the **cell plate** ;
- Cell plate extends across the **equator** of the parental cell ;
- **Contents** of Golgi vesicles contribute to the **cell wall** of the daughter cells while their **membranes** form the **cell surface membranes** of the daughter cells ;
- Cell plate **fuses** with the parent cell wall and cell membrane, **separating** the two daughter cells.





Not in notes

14 The photo electron micrographs show early and late stages in the development of the cell wall in a young plant cell.



Which statement describes the events leading to the development of the cell wall?

A Complex carbohydrates assembled in the Golgi body are exported to the cell wall by the Golgi vesicles.

B Enzymes in the cell surface membrane synthesise the cell wall components from soluble carbohydrates brought by the Golgi vesicles.

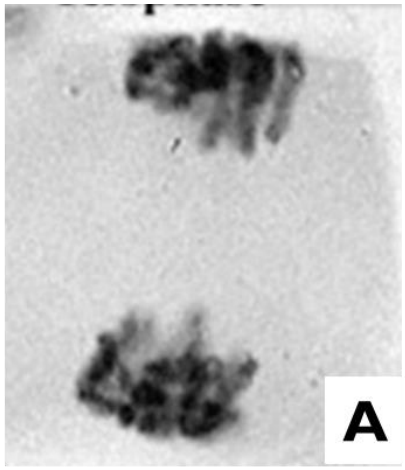
C Polysaccharides are exported to the cell wall and synthesized into wall components by the Golgi body.

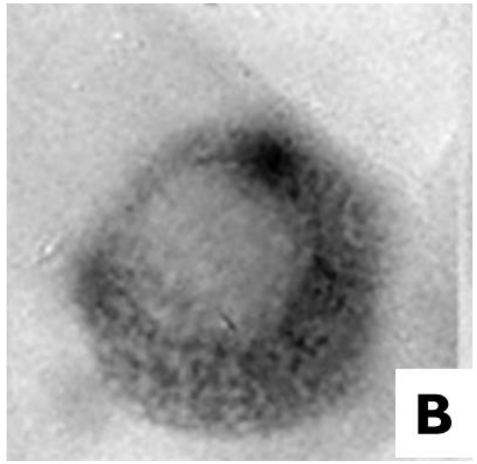
D Ribosomes synthesise glycoproteins that are exported by Golgi vesicles to be used in the cell wall.

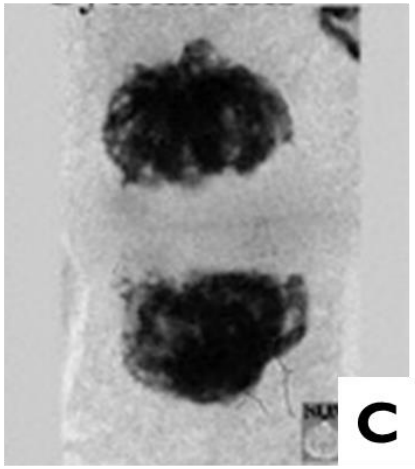
https://www.youtube.com/watch?v=t1JdFVsyWkI

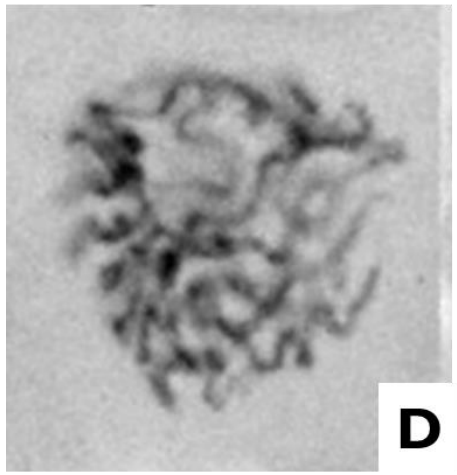
Not in notes

CAN YOU ORDER THE EMS IN THE CORRECT SEQUENCE?





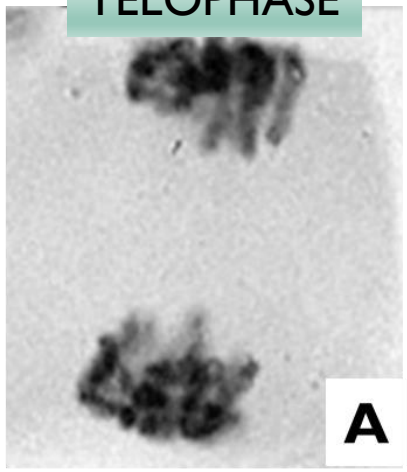




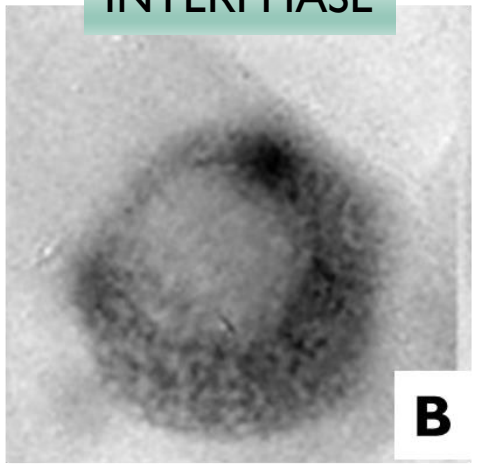
Not in notes

CAN YOU ORDER THE EMS IN THE CORRECT SEQUENCE?

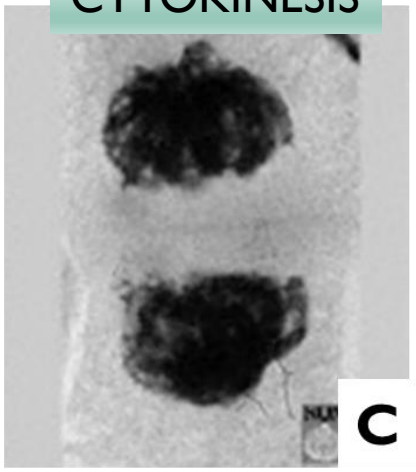
TELOPHASE



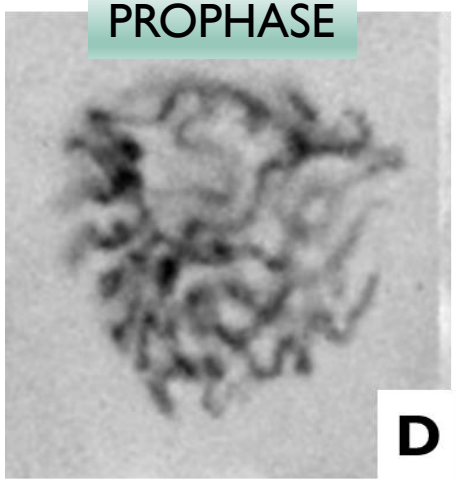
INTERPHASE



CYTOKINESIS

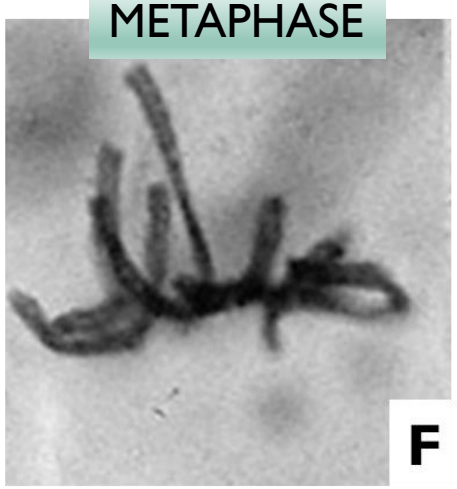


PROPHASE

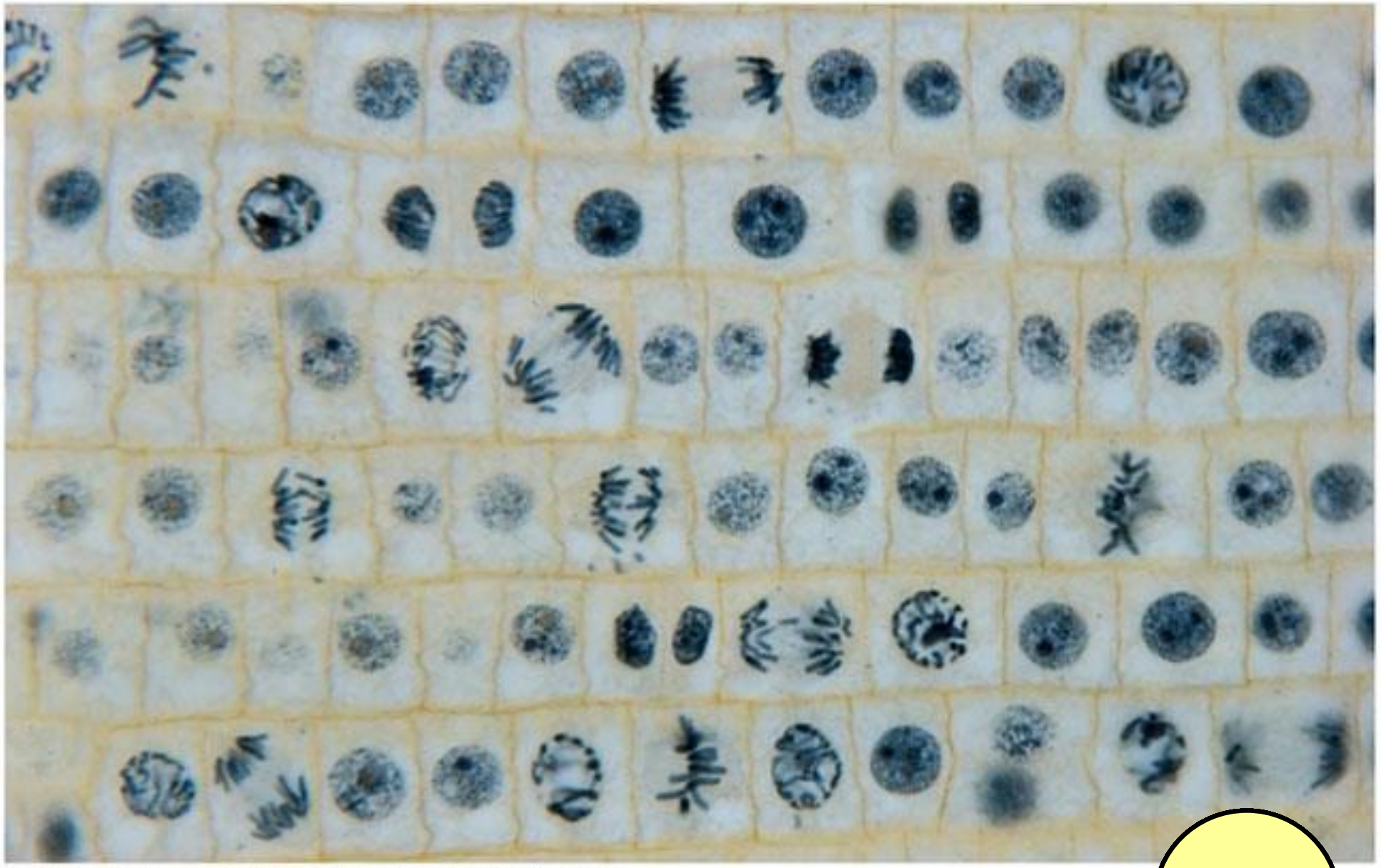


ANAPHASE

METAPHASE



B, D, F,
E, A, C



End

LEARNING OBJECTIVES

(f) describe the events that occur during the mitotic cell cycle and the main stages of mitosis (including the behaviour of chromosomes, nuclear envelope, cell surface membrane and centrioles)

(g) explain the significance of the mitotic cell cycle (including growth, repair and asexual reproduction) and the need to regulate it tightly (knowledge that dysregulation of checkpoints of cell division can result in uncontrolled cell division and cancer is required, but details of the mechanism are not required)

2) SIGNIFICANCE OF MITOTIC CELL CYCLE

- Mitosis being a type of nuclear division aids in the formation of **daughter cells** that are **genetically identical** to the **parents**.
- The daughter cells formed from mitosis has:
  a) **identical chromosomes number** (diploid number or haploid number depending on parental cells) i.e. same number of chromosomes
  b) **exact genetic information**
  i.e. same DNA sequence

PRODUCTION OF GENETICALLY IDENTICAL CELLS

- The production of genetically identical cells is important for **genetic stability** in processes like *growth, repair and asexual reproduction*.
- This genetic stability is achieved through the process of **semi-conservative replication of DNA** during the S phase of interphase where the integrity of the genetic information is retained during the doubling of the DNA.

SIGNIFICANCE OF MITOTIC CELL CYCLE

- It is crucial that the new cells are GENETICALLY IDENTICAL as the parent cells that they are replacing, in the processes stated as follows:
  a) **Growth**
  b) **Repair**
  c) **Asexual reproduction**

SIGNIFICANCE - A) **FOR GROWTH**

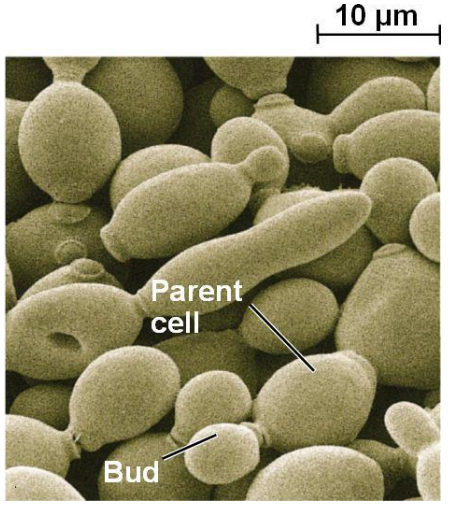
- Increase in number of genetically identical cells within the organism (e.g. growth and development of a multicellular organism from zygote to a foetus)
- **IMPACT**: For tissue growth, increase in number of genetically identical cells within the organism ensures that **new cells are genetically identical to existing cells** so that they carry out the **same function**.

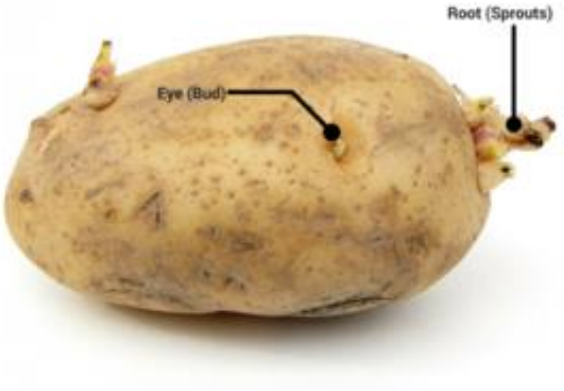
SIGNIFICANCE - B) **FOR REPAIR**

- **Regeneration** of cells and tissues **lost** in normal processes of wear and tear, aging, damage and disease
- **IMPACT**: Ensures that damaged cells lost in normal processes of wear and tear and disease are **replaced** with **exact copies** of the original cells in order for the tissue to **function properly.**

SIGNIFICANCE - C) FOR ASEXUAL REPRODUCTION

- Reproduction of an organism without production of gametes. Examples:
  - budding in *Hydra* and yeast,
  - vegetative propagation in potato
- **IMPACT**: Ensures that offspring are genetically identical to the parent for continued survival of the species / retains advantage of the organism in adapting to its environment





LEARNING OBJECTIVES

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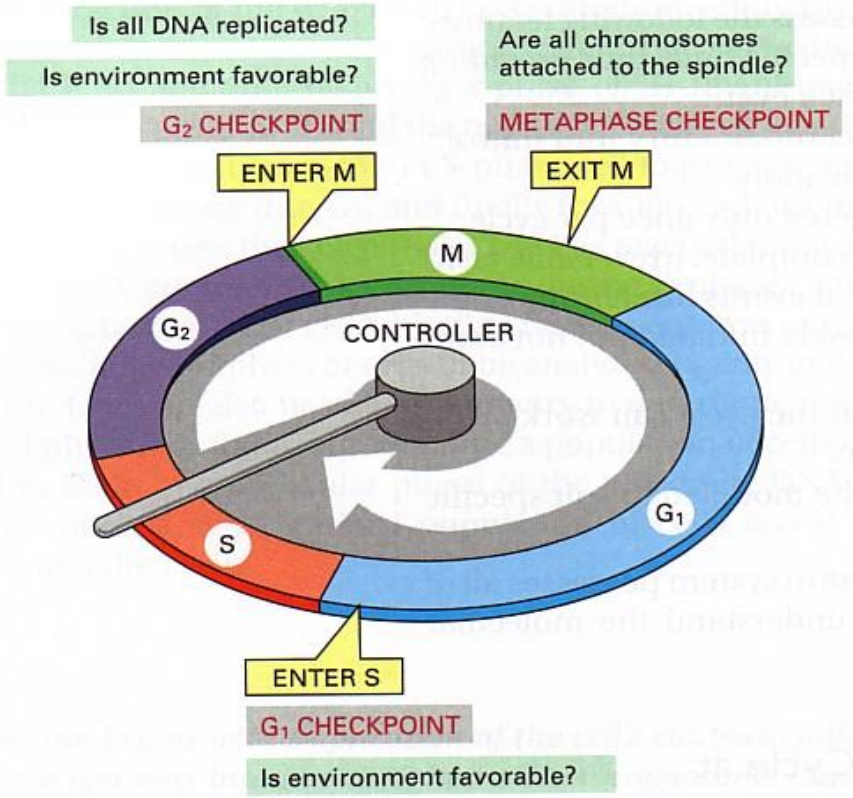
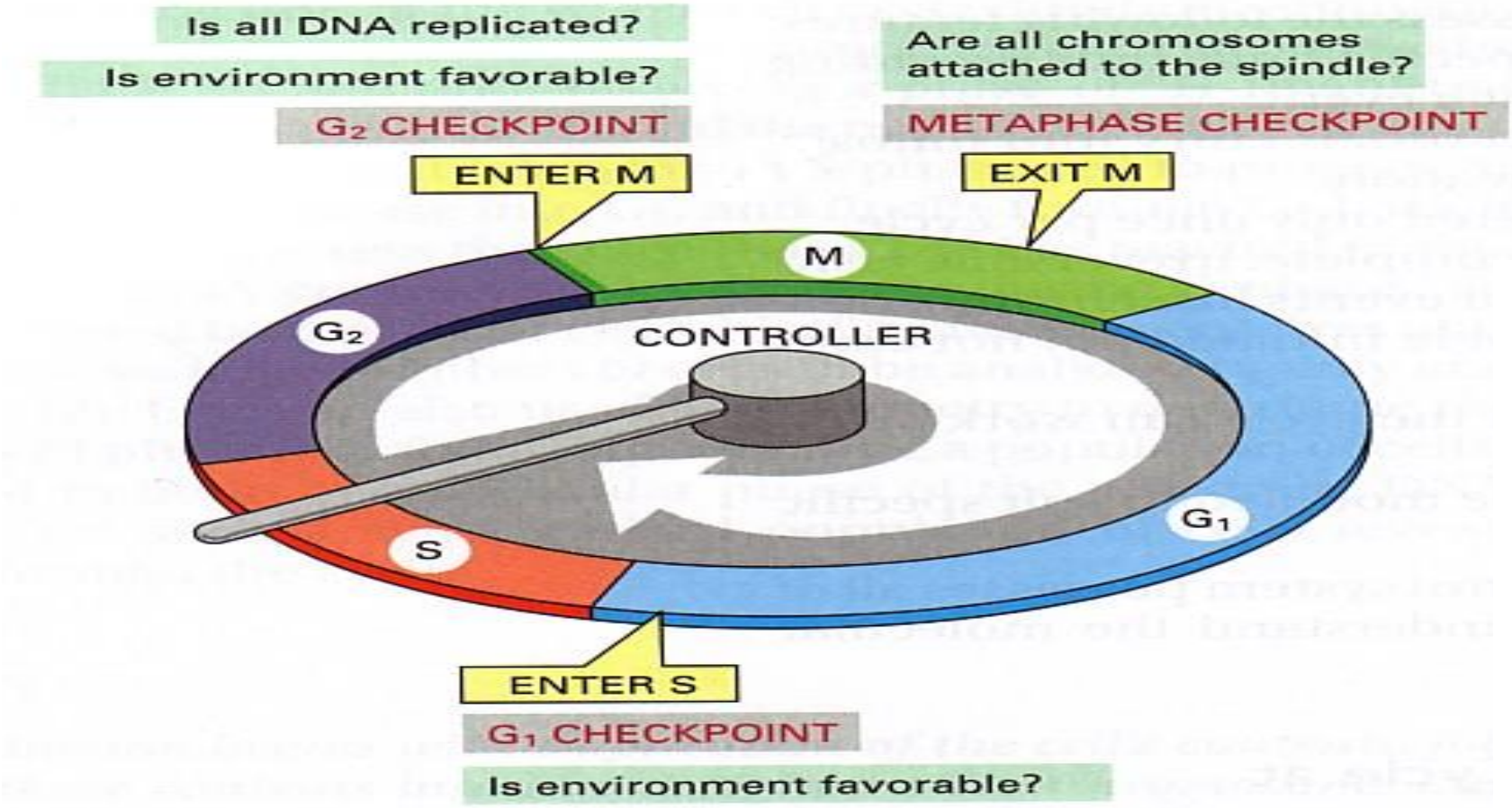
3) NEED TO REGULATE CELL CYCLE

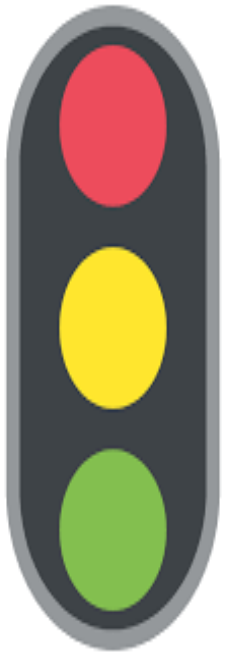
Cell division in normal cells is regulated via **checkpoints**.

The cell cycle control system is made up of a complex network of **regulatory proteins**.



3) NEED TO REGULATE CELL CYCLE

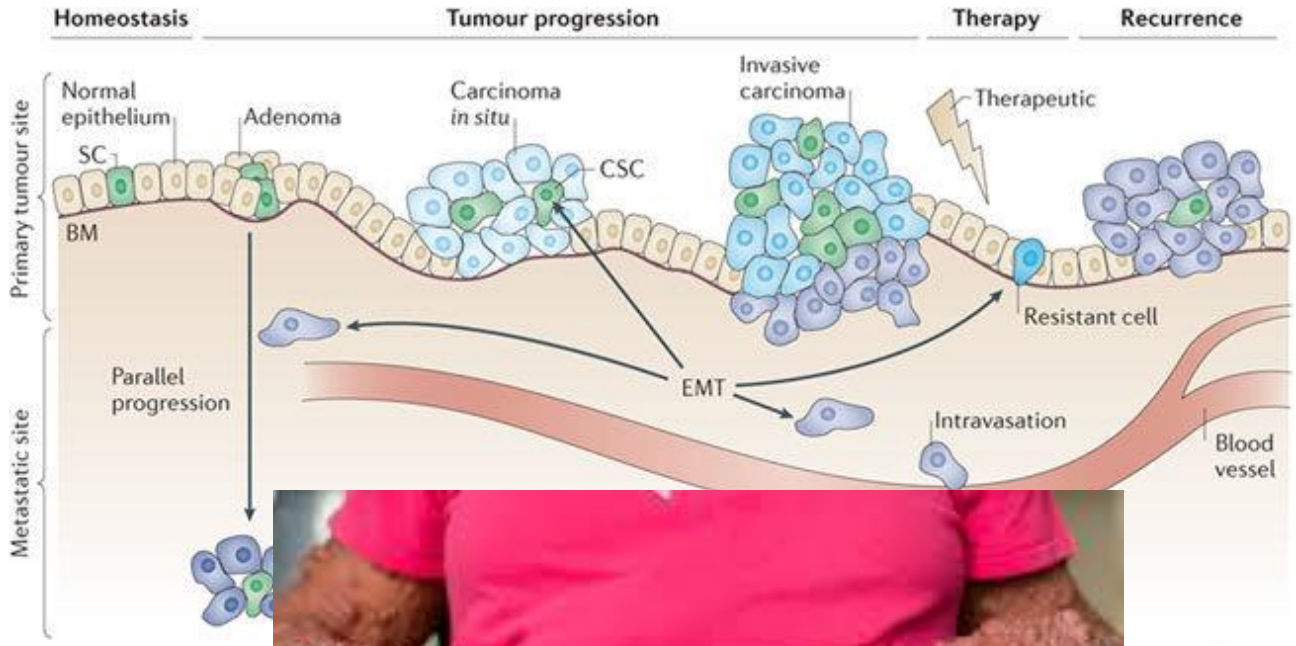




NEED TO REGULATE CELL CYCLE FOR: PREVENT DEVELOPMENT OF CANCER

- Dysregulation of the cell cycle could contribute towards tumour or cancer formation!

More in CANCER lecture!



SUMMARY – MITOSIS RAP BY MR M

https://www.youtube.com/watch?v=pOsAbTi9tHw