

## Understandings:

### 1. Give an overview of mitosis.

- Mitosis is an asexual reproduction of a cell that produces two genetically identical daughter cells. Mitosis is divided into four phases: prophase, metaphase, anaphase and telophase (PMAT).

So when does mitosis happen? It happens when the cell needs to grow such as embryo, repair tissues and reproduce asexually which is primarily for unicellular organisms.

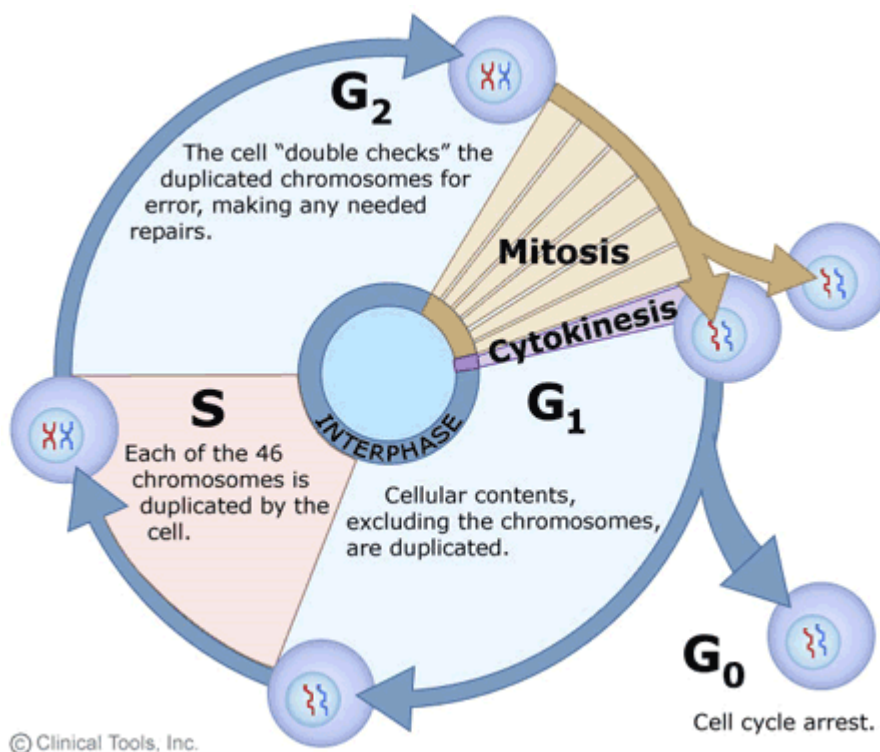
### Extra notes

- Note that mitosis is only a small part of the cell cycle. The cell consists of cell division and interphase.

Cell division = mitosis + cytokinesis

Interphase = G<sub>1</sub> + S + G<sub>2</sub>

Note that G<sub>0</sub> is simply a “pause” from the cell cycle. This is because cells don’t constantly divide. They divide only when it is necessary. Thus when they don’t divide, they are in the G<sub>0</sub>.



## 2. Explain interphase.

- The whole idea of interphase is to prepare the cell for mitosis by replicating its content. We have seen that they have three active phases, G1, S and G2, but what happens there?

In G1, the cell grows and everything is replicated including mitochondria, ER, Golgi apparatus, etc. except the DNA material.

In S, the DNA material is replicated. Note that the DNA material exists in long strands.

In G2, the cell prepares by producing necessary proteins for replication and may grow even more. Basically, it is a phase where the cell checks that they have everything they need to replicate. Some organisms, like *Xenopus* embryos do not even have G2.

## 3. Explain that chromosomes condense by supercoiling during mitosis.

- At the end of G2, the genetic material is still loose and long. In the first step of mitosis prophase, DNA is condensed through supercoiling. The reason cells do this is to make the DNA more compact and make it fit in the nucleus.

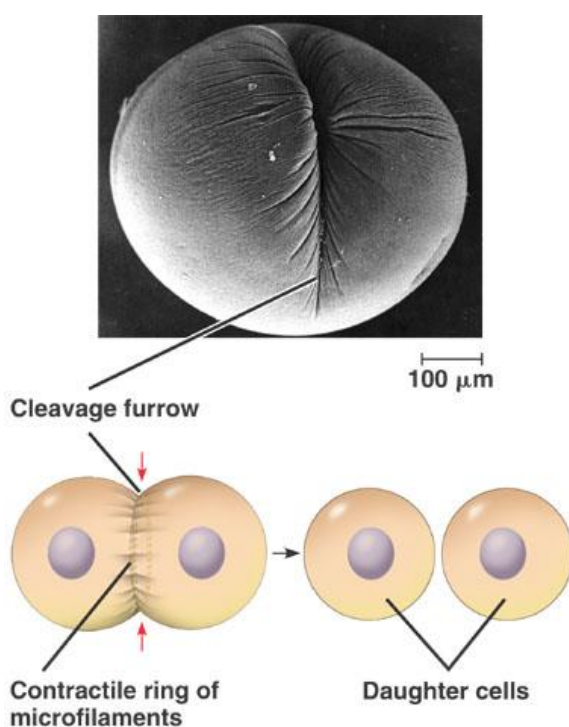
Supercoiling moves from chromatin (unwounded DNA material) → chromosome with two sister chromatids.

## 4. Explain cytokinesis.

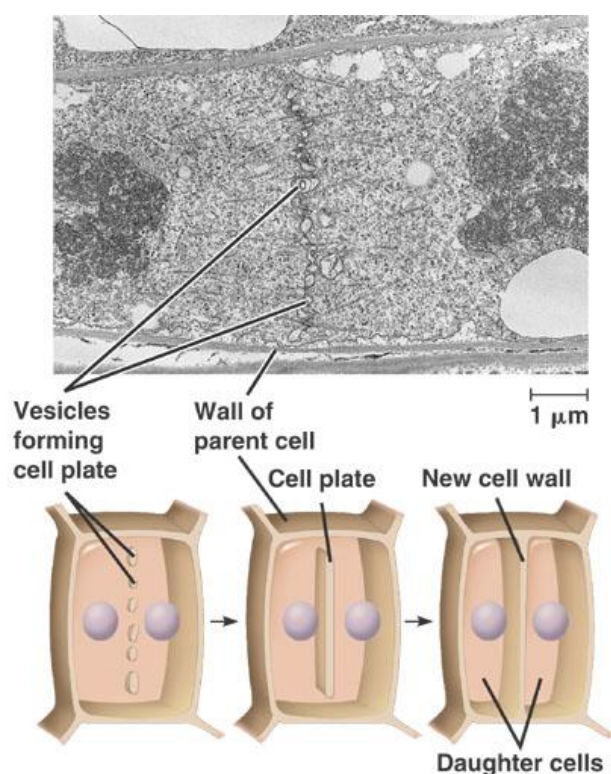
- This is basically when the cell splits after mitosis and animal cells and plant cells do it differently.

Animal cells simply use actin and myosin to cleave the cell in the middle and almost “pinch” the cell into two.

Plant cells develop an internal membrane by vesicles and then export cellulose and pectin (both are constituents of cell wall) to form a cell wall.



(a) Cleavage of an animal cell (SEM)



(b) Cell plate formation in a plant cell (TEM)

## 5. Explain what cyclins are.

- Cyclin is a protein group. This protein controls the timing of the stages in cell division. Cell division simply doesn't know when to divide itself, so cyclins act as signals. In order to process to the next step, there must be certain concentration of cyclins.

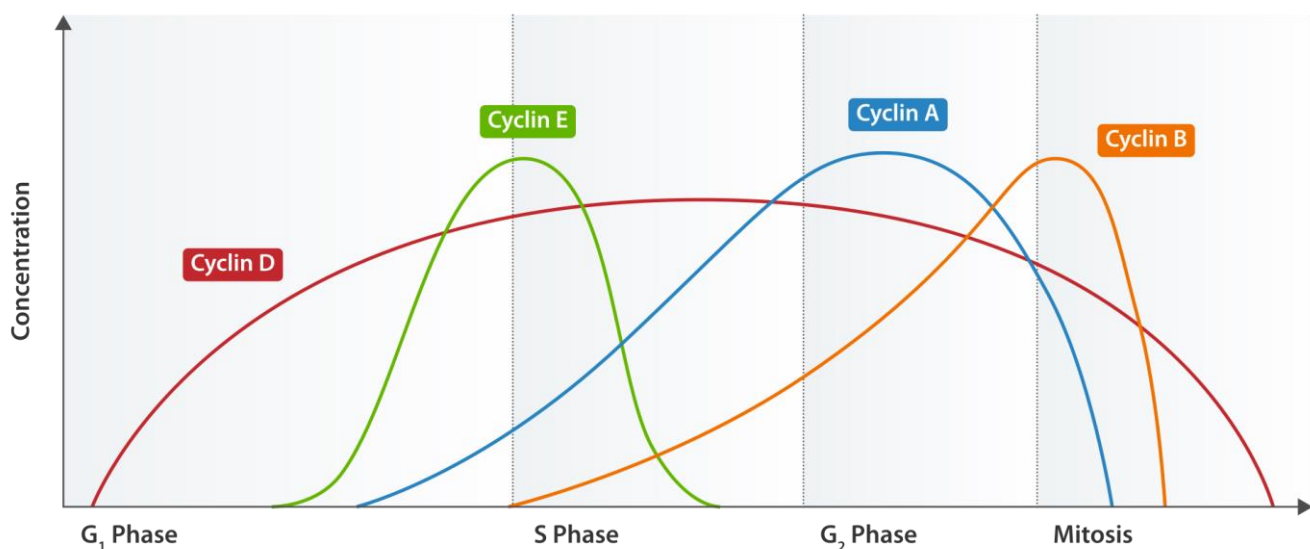
An overview would be:

Cyclin D → activates cyclin-dependent kinase → activates other molecules including cyclin E

Cyclin E → activates cyclin-dependent kinase → activates other molecules including cyclin A

Cyclin A → activates cyclin-dependent kinase → activates other molecules including cyclin B

Cyclin B → activates cyclin-dependent kinase → activates other molecules including cyclin D



## 6. Explain mutagens, oncogenes and metastasis and their contribution to secondary tumors.

- Tumor is abnormal division of cells. However, not all are harmful. Only the ones that can migrate and develop what is so called secondary tumors is dangerous. Dangerous tumor is known as cancer.

Mutagen is any type of substance that is able to form mutation. Carcinogen is any type of substance that can form cancer. Now, since mutation in the genes can definitely form cancer, it logically follows that all mutagens have ability to form cancer. Therefore all mutagens are a type of carcinogen.

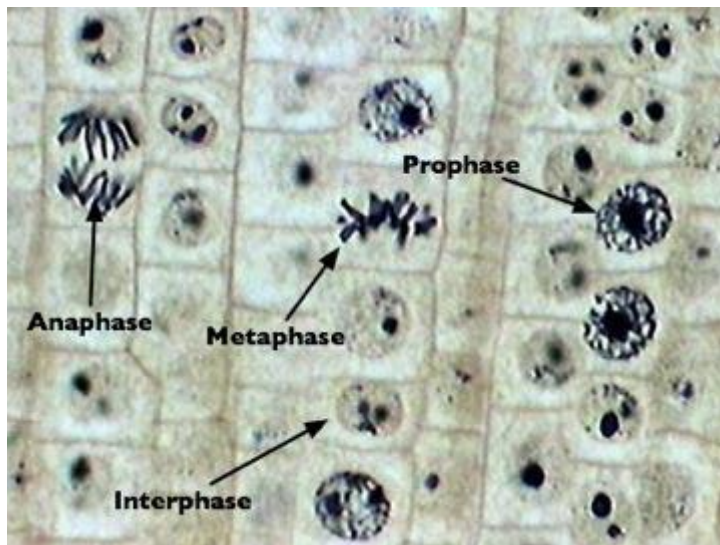
Now, mutations have to be specifically in certain genes in order to form cancer. Since it is all about abnormal cell division, it is logical that mutations that affect genes that regulate cell cycle leads to cancer. These genes affected to form cancer is called oncogenes. "Onco" means tumor in Greek.

## Applications and skills:

### 1. Explain the correlation between smoking and incidence of cancers.

- It has been shown for many years that there is a correlation between smoking and cancer. However, correlation is not necessarily causation. But it is now established that tens of molecules in cigarette are carcinogenic.

### 2. Be able to identify phases of mitosis in cells viewed with a microscope or in a micrograph.



Stage	Description
Prophase	The <u>chromatins</u> supercoil to <u>chromosomes</u> with two sister chromatids. The <u>centrosomes</u> (containing centrioles) move to opposite poles. Webs (called <u>microtubules</u> ) start to grow from <u>centrioles</u> . Then the <u>nuclear membrane breaks down</u> .
Metaphase	The chromosomes start to line up normal to the two poles. Then the microtubules attach to the center of the chromosome, which is the <u>kinetochore</u> . The <u>centromeres</u> are what holds the sister chromatid together, but the <u>kinetochores</u> are what the spindles of microtubules attach to.
Anaphase	Microtubules contract and the sister chromatids are pulled to opposite sides. The <u>centromeres therefore break down</u> .
Telophase	Nuclear membrane forms in both two sister chromatids, which are now individual chromosomes. The <u>chromosomes now uncoil</u> , forming a <u>chromatin</u> , which are the free bundles of DNA with histone proteins. The microtubules break down. We now come back to cytokinesis, where the actual plasma membrane divides.

**3. Be able to determine a mitotic index from a micrograph.**

- Mitotic index = 
$$\frac{\text{Number of cells undergoing mitosis}}{\text{Total number of cells in the sample area}}$$

Some obvious characteristics of mitosis is no nuclear membrane, chromosomes moving to opposite poles, condensed chromosome, two smaller cells attached to each other.

**TOK:**

**1. A number of scientific discoveries are claimed to be incidental or serendipitous. To what extent might some of these scientific discoveries be the result of intuition rather than luck?**