

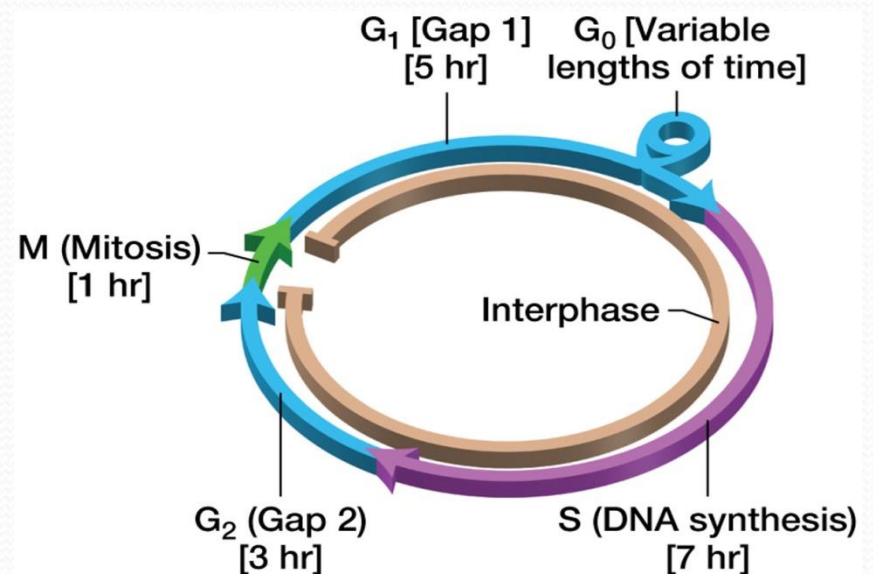
Zoo-352 Principles of genetics
Lecture 3

The cell cycle and its checkpoints

The cell cycle:

- The continuity of life depends on cells growing, replicating their genetic material, and then dividing- a process called the **cell cycle**.
- The interval time between each mitotic cell division **is termed a cell cycle**.
- **The cell cycle consists of two basic stages: interphase and M phase.**
- **Interphase** can be subdivided into **three** ordered stages: **G1** (Gap 1), **S** (DNA synthesis) and **G2** (Gap 2) (Figure 1).

Figure 1: Typical cell cycle of a human cell



- **S phase** is defined as the stage where the **DNA replication** occurs.
- **M phase** is where the cell is ready **to divide** into 2 daughter cells.
- There are **two gaps** between the S and M phases, G1 and G2.
- In the **G1** phase, the cell is growing and also preparing for the process of DNA replication.
- in the second gap, **G2**, which comes after the S phase, the cell prepares for the process of division.
- The cell cycle can continue for the life of some cells. Other cells, such as **neuron (nerve cell)**, do not continue to grow and divide after they completely differentiate.
- These cells leave the cell cycle and enter the **G0** phase, where they remain metabolically active and viable.
- Some cells also enter the **G0** temporarily and then reenter the cell cycle.

- Occasionally, cells either fail to enter G0 phase or do not remain in the G0 phase, which results in their continual proliferation (**growth and division**). This uncontrolled cell proliferation can lead to **cancerous growth**.
- The length of time required for a complete life cycle varies with cell type.
- Mitosis (M phase) is usually the **shortest period**.
- Mitosis or the M phase has four stages:
 1. Prophase
 2. Metaphase
 3. Anaphase
 4. telophase.

Video

http://highered.mheducation.com/sites/007298760x/student_view0/chapter3/how_the_cell_cycle_works.html

Cell cycle checkpoints:

- Some points in the cell cycle, such as the initiation of mitosis can be delayed until all necessary conditions are in place, such as the repair of the damaged DNA.
- These checkpoints allow the cell to make sure that various events have been properly completed before it moves to the next phase of the cell cycle.
- There are **three major checkpoints** in the cell cycle (Figure 2):

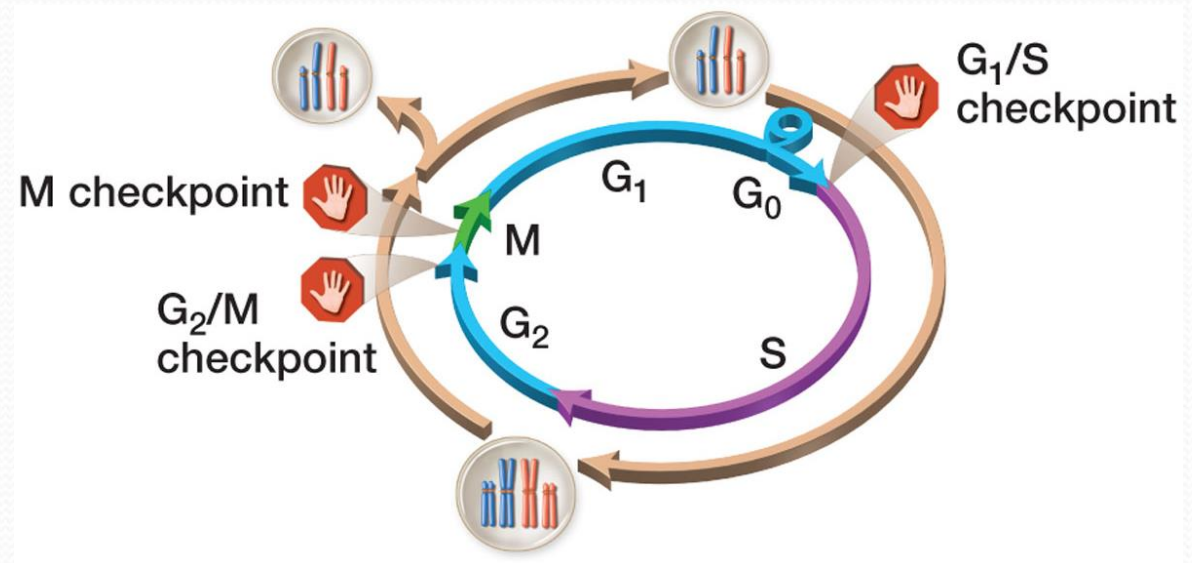


Figure 2: Cell cycle checkpoints

1. The G1/S checkpoint:

- Determines whether the cell has reached the proper size and determines if the DNA is damaged.
- For example, if the cell attempts to replicate damaged DNA, breaks will occur in the DNA or replication will be blocked.

2. The G2/M checkpoint:

- Evaluates whether DNA replication is completed and if any damaged DNA still needs to be repaired.

3. The M checkpoint:

- Evaluates whether spindle fibers are properly assembled and attached to the kinetochores.
- If either of these two events is not completed, the chromosomes cannot faithfully be separated into the daughter cells.

- The cell cycle routinely arrests when genetic damaged is present, giving the cell a chance to repair the damage before committing to cell division.
- If the damaged is too extreme, the cell can enter a **programmed cell death (apoptosis)**.
- If the G1/S checkpoint detects DNA damage, the **p53** protein targets the cells for regulated death.
- If the *p53* gene is defective, then the controlled death of the damaged cells would not take place, and the possible uncontrolled cell growth would result in **cancer**.
- In fact, a number of **human cancers**, including colon, breast, and lung cancers, have been shown to be associated with **mutations in the *p53* gene**.

Video

http://highered.mheducation.com/sites/007298760x/student_view0/chapter3/control_of_the_cell_cycle.html