AP BIOLOGY · UNIT 4 · TOPIC 4.5

Cell Cycle

Learning objective 4.5.A Describe the events that occur in the cell cycle.

Name: Date: Period:

Use the tool **Copy, Check, Divide**. Parts 1 and 2 use **Around the cycle** and **Two counters**, in that order, and Part 3 uses the **How long is each phase?** tab. Throughout, the cell has **2n = 6** chromosomes, and DNA is counted in units in which one unreplicated chromosome is 1, so a G1 cell holds 6 units. Two counters run the whole time: the number of chromosomes and the amount of DNA. They change at different stages, except at cytokinesis, when both are halved.

Part 1 · Two counters, all the way round

Open **Around the cycle** and step through all eight stages with **Forward**. Fill in the table as you go, from the Chromosomes, Chromatids per chromosome and DNA (units) readouts. Before you press Forward for each row, **predict** the chromosome number and the DNA amount.

Stage	Chromosomes	Chromatids each	DNA (units)	Which counter moved?
G1				
S				
G2				
Prophase				
Metaphase				
Anaphase				
Telophase				
Cytokinesis				

1. (a) Identify the stages in the Part 1 table that make up interphase.

(b) Identify the stages in the Part 1 table that make up M phase.

2. (a) Identify the stage at which the amount of DNA increases.

(b) Explain why the number of chromosomes does not change at this stage.

Part 2 · The two doublings

Switch to **Two counters** and move the Highlight a stage slider along the stages. The DNA graph steps up once and the chromosome graph steps up once, at **different stages**. Complete the table from what the two graphs show.

	S phase	Anaphase
What physically happens		
Chromosome number: before → after		
DNA amount: before → after		
Chromatids per chromosome: before → after		
Visible on a DNA-content graph?		

3. Explain why the number of chromosomes doubles during anaphase, even though no DNA is made.

4. A graph of the DNA content of one cell is flat from G2 through telophase.
(a) Explain why anaphase cannot be located on this graph.

(b) Identify the data that would be needed to locate anaphase.

Part 3 · Counting cells to get times

Switch to **How long is each phase?** with **Field A** selected and the cycle set to **24 h**. Calculate each row on paper first, then check it against the table in the tool. Use **duration = (cells in that phase ÷ total cells) × cycle length**.

Phase	Cells (of 200)	Fraction	Duration
G1	88		
S	52		
G2	30		
Prophase	16		
Metaphase	6		
Anaphase	3		
Telophase	5		

5. Describe the assumption about the cells that this method depends on.

6. Select Field B, which counts 400 cells.
(a) Describe the effect of counting 400 cells instead of 200 on the durations.

(b) Explain why counting more cells has this effect.

Part 4 · Putting it together

Answer questions 7 to 9 without the tool, using the two counters and the counting rule.

7. A cell has 6 chromosomes and 6 units of DNA in G1. Identify the number of chromosomes and the DNA content, in units, at G2, at metaphase, at anaphase and in each daughter cell.

8. Explain why the two cells produced by mitosis are genetically identical to the parent cell.

9. In a field of 200 root-tip cells, 3 are in anaphase and 88 are in G1. The cell cycle takes 24 hours.
(a) Calculate the length of anaphase. Show your work.

(b) Explain why the estimate for anaphase is less reliable than the estimate for G1.

What the model simplifies

The cell is drawn with 2n = 6 so the chromosomes can be told apart. A human cell has 46, and no diagram of 46 chromosomes would be readable; the counting rules are identical whatever the number.

DNA is measured in units where one unreplicated chromosome is 1, so a G1 cell here holds 6 units. Textbooks often write the same quantity as 2c for the whole G1 cell and 4c after replication. The two notations say the same thing.

Prophase is drawn as one stage. Some courses split off prometaphase, when the nuclear envelope has gone and the spindle fibers attach to the centromeres; the 2025 CED lists four stages of mitosis, and that is what is shown.

The eight stages are drawn as equal steps, which they are not; Part 3 is partly there to correct that impression. Cytokinesis is drawn as a separate stage because it is a separate event; it overlaps telophase in a real cell.

The 200-cell field is a plausible set of counts for an onion root tip, not a record of one real slide. It is used because the arithmetic has to be checkable; a real count would carry sampling error, which question 9 raises.