The cycle and mitosis

60 minutes • 4.5.A, 4.5.B • Chapters 1, 2, 3, 4, 5, 6 • The dry lab

Why cells divide, chromosomes and chromatids, the stages of the cell cycle and G0, the phases of mitosis and cytokinesis, with a modeling task and the mitotic index lab

BY THE END, STUDENTS CAN

- [ ] Explain how mitosis passes a complete genome to two genetically identical daughter cells, and its roles in growth, tissue repair and asexual reproduction 4.5.B
- [ ] Describe a chromosome before and after its DNA is copied, and why chromosomes condense before mitosis 4.5.B
- [ ] Describe the stages of the cell cycle (G1, S, G2, mitosis and cytokinesis) and how a cell can leave the cycle into G0 or be held at a stage 4.5.A
- [ ] Describe prophase, metaphase, anaphase and telophase, and track the number of chromosomes and chromatids through them 4.5.B
- [ ] Compare cytokinesis in animal and plant cells 4.5.A

TIMING

0–5	5 min	**Do now: how a cut heals**	
5–12	7 min	**One cell, two copies**	
12–19	7 min	**Around the cycle**	
19–29	10 min	**Watch it divide**	
29–43	14 min	**Model mitosis**	
43–55	12 min	**Count the cells**	
55–60	5 min	**Exit**	
	60 min	**One lesson**	

STARTER

5 min

Do now: how a cut heals

"You cut your finger. Two weeks later the skin is whole again. Where did the new cells come from, and what must each one have been given?" Pairs write two sentences. Land on: from existing cells dividing, and each new cell needs a full set of DNA.

ON THE BOARD, FROM THE GUIDE

Open the guide on the projector at each chapter (the links work in this PDF). Every figure plays from its own buttons, and the lesson's slides have the same figures, step by step, in the order of this plan.

01 One cell, two copies

CHAPTER 01 IN THE SLIDES

Step through the figure (3 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. A **parent cell** grows to about twice its starting size.
2. Its **nucleus divides** first, so there are two.
3. Then the cytoplasm divides: two **daughter cells**, each with a nucleus.

> **Predict box:** A gardener cuts a stem from a geranium and it roots into a new plant. How do the new plant's cells compare with the parent plant's? Hands up or mini whiteboards first.
>
> **Answer C: They have the same genome as the parent, since every one was made by mitosis from its cells**

02 Copied, then coiled

CHAPTER 02 IN THE SLIDES

Step through the figure (4 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. Before it is copied, a chromosome is **one DNA molecule**, long and thin.
2. After copying it is **two sister chromatids**, joined at the centromere.
3. As division begins the DNA winds around **histones** and coils into a short, thick chromosome.
4. **Microtubules** from both poles attach at the centromere and pull.

> **Predict box:** A cell has 8 chromosomes before it copies its DNA. How many DNA molecules are in its nucleus as mitosis begins? Hands up or mini whiteboards first.
>
> **Answer A: 16, because each of the 8 chromosomes is now two sister chromatids**

03 Around the cycle

CHAPTER 03 IN THE SLIDES

Step through the figure (6 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. The **cell cycle**: one turn is one division.
2. **G1**: the cell grows and makes proteins and organelles.
3. **S**: the DNA is copied.
4. **G2**: more growth and preparation for division.
5. **Mitosis**: the nucleus divides.
6. **Cytokinesis**: the cytoplasm divides, giving two cells, each back in G1.

> **Predict box:** Compare a cell in G2 with the same cell earlier, in G1. What does it have in G2? Hands up or mini whiteboards first.
>
> **Answer B: Twice the DNA, because every chromosome has been copied into two chromatids**

> **Remember it:** Giraffes Sing Gorillas Make Chili (G1, S phase, G2, Mitosis, Cytokinesis).

04 A complete genome, twice

CHAPTER 04 IN THE SLIDES

Play the animation, Mitosis, one phase at a time. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

1. After copying, each chromosome is **two DNA molecules**, the sister chromatids, held together at the centromere.
2. The **nuclear membrane** breaks down and the centrosomes move apart. **Spindle microtubules** grow from them.
3. **Metaphase.** Microtubules from both poles attach to each centromere and line the chromosomes up on the **equator**.
4. **Anaphase.** The centromeres split. Microtubule motors pull the **sister chromatids** to opposite poles.
5. **Telophase.** A nuclear membrane forms round each group, the chromosomes uncoil and the spindle breaks down.
6. **Cytokinesis.** A ring of actin and myosin pinches the cell in two. Each daughter nucleus has one copy of every chromosome: they are **genetically identical**.
7. Prophase, metaphase, anaphase, telophase: make up your own way to remember the order.

Show the figure: The short version, on a loop: chromosomes line up on the spindle, the chromatids are pulled apart, and one cell becomes two.

> **Predict box:** A dog's body cells have 78 chromosomes. A skin cell divides by mitosis. How many chromosomes does each daughter cell have? Hands up or mini whiteboards first.
>
> **Answer C: 78, because each daughter cell gets one chromatid of every chromosome**

05 Four phases, one at a time

CHAPTER 05 IN THE SLIDES

Step through the figure (7 steps, the arrow keys on a projector). Stop on each caption and ask what changed before you go on.

1. Five drawn cells from a root tip. **Name each one** before you go on.
2. **Interphase**: a round nucleus and a dark nucleolus.
3. **Prophase**: thick threads, the nuclear envelope going.
4. **Metaphase**: chromosomes in a line across the middle.
5. **Anaphase**: chromatids pulled to opposite ends.
6. **Telophase**: two nuclei and a new cell plate.
7. In the order of the process: 3, 1, 5, 2, 4.

> **Predict box:** The drug colchicine stops microtubules forming. Root tip cells are soaked in it for a few hours. Where do the dividing cells get stuck? Hands up or mini whiteboards first.
>
> **Answer A: Condensed, as in early metaphase, but never lined up or pulled apart**

> **Remember it:** Penguins March Across Town (Prophase, Metaphase, Anaphase, Telophase).

06 Splitting the cytoplasm

CHAPTER 06 IN THE SLIDES

Play the animation, Splitting the cytoplasm. It loops; pause it on each moment below and ask what is happening (in the lesson slides it is a video).

1. In an **animal cell**, a ring of **actin and myosin** just inside the membrane contracts and pinches the cell in two.
2. Mitochondria are only made by dividing old ones, so **each daughter cell must get at least one**.
3. A **plant cell** has a wall, so it cannot be pinched. Vesicles carry membrane and wall material to the equator.
4. The vesicles fuse into a **cell plate**, which grows outwards until it meets the side walls.
5. The plate becomes two membranes with **new cell wall** between them: two cells.
6. Cytokinesis is usually equal, but not always. A human **egg cell** keeps almost all the cytoplasm and pinches off a tiny **polar body**.
7. **Yeast** divides by **budding**: a small bud grows out, one nucleus moves into it, and it pinches off.

> **Predict box:** A drug stops actin filaments forming but leaves microtubules alone. What happens when an animal cell treated with it divides? Hands up or mini whiteboards first.
>
> **Answer B: Mitosis finishes, but no furrow forms, leaving one cell with two nuclei**

THE LESSON

7 min

One cell, two copies

Chapter 1's figure, then chapter 2's: one DNA molecule, two sister chromatids, coiled. Students count the chromosomes and chromatids on a mini whiteboard at each step. Then chapter 2's predict box.

7 min

Around the cycle

Chapter 3's figure, a stage per caption. Students sketch the cycle as a pie and write what the cell makes in G1, S and G2. Ask where a nerve cell sits, and what G0 means for a liver after an injury.

10 min

Watch it divide

Chapter 4's film straight through, then again with pauses: pairs say the phase before the caption does. Chapter 5's figure and its table of counts, then chapter 6's film, stopping on the furrow and the cell plate.

14 min

Model mitosis

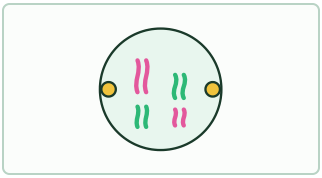
The pipe cleaner model below: pairs take a cell of four chromosomes through S phase and the four phases on a drawn cell, photographing each, then explain to another pair why the two nuclei are identical.

12 min

Count the cells

The dry lab on the Lab tab: each pair marks and counts three root tip fields and three from further back, and works out the mitotic index of each as a percentage.

ACTIVITIES

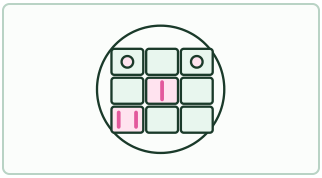


MODEL

Model mitosis

Each pair has a large circle drawn on paper (the cell), four pipe cleaners in two colors and two lengths (a long and a short chromosome from each parent), four more to make the copies, small beads or twists as centromeres, two buttons as the poles, and string for spindle fibers. They copy each chromosome in S phase, twisting the copies together at the centromere, then take the cell through prophase, metaphase, anaphase and telophase, photographing each phase. Last, they split the circle with a pencil line for cytokinesis and check that each daughter cell has one of each chromosome.

Needs: per pair, eight pipe cleaners in two colors, beads, two buttons, string, a large sheet of paper, a phone camera.



DRY LAB

Count the cells

The dry lab on the Lab tab, with its tasks and questions under it. Pairs name every dividing cell in a field by eye before they count, then work out the mitotic index as a percentage for three fields of each sample and compare the means. If the class has onion or garlic root tip slides, they can count a real field the same way. It works on a phone as well as a laptop, and the results download as a CSV.

Needs: one device per pair; microscopes and root tip slides if you have them.

PLENARY

5 min

Exit

On paper: "A cell has 12 chromosomes in G1. Give the number of chromosomes and of chromatids in G2, in anaphase and in each daughter cell."

WHAT STUDENTS GET WRONG

"Interphase is when the cell rests." It grows, makes proteins and organelles, and copies all of its DNA in S phase.

"After S phase the cell has 92 chromosomes." Count centromeres: it has 46 chromosomes, each of two sister chromatids. The number doubles only in anaphase, when the centromeres split.

"Cytokinesis is the last phase of mitosis." Mitosis divides the nucleus; cytokinesis divides the cytoplasm.

"In metaphase, matching chromosomes pair up." In mitosis each chromosome lines up on its own; pairing is meiosis, in Unit 5.

STRETCH AND SUPPORT

Stretch: a cell in a root tip goes around its cycle in 20 hours, and 4 percent of the root tip cells are in metaphase. Estimate how long metaphase lasts, and say what you assumed.

Stretch: a mature red blood cell has no nucleus. Why can it never divide?

Support: the captions of chapter 4's film as a cut-up storyboard to put in order before writing the phases.

For revision: students can drill this unit's key terms on Cramly.

IN THE GUIDE

1 One cell, two copies
2 Copied, then coiled
3 Around the cycle
4 A complete genome, twice
5 Four phases, one at a time
6 Splitting the cytoplasm
Lab Dry lab: Count the cells
All The whole guide, with the figures that play
PPTX This lesson's slides, in the order of this plan

EXAM PRACTICE

Check yourself

Set it for homework: a fresh paper of exam-bank questions on 4.5 and 4.6 each time, marked as students go and saved to their Exam practice when they are signed in.

biologybybradford.com/exam-maker/sit?program=ap&units=U4&ced=4.5,4.6&paper=quiz&marks=15&src=ep

PRACTISE AND REVISE

BUILD FOR YOUR CLASS

- Tarsia puzzle, dominoes and picture reveal on Unit 4, built from its key terms and ready to print
- A pub quiz with rounds on Unit 4, to present or run with no projector
- The Silent Relay Station escape room, or an escape room built from the question bank on Unit 4

ALREADY ON THE SITE FOR UNIT 4

- Quiz: The Cell Cycle
- Quiz: Regulation of the Cell Cycle
- Exam questions: Unit 4 in the exam maker, a paper with scoring guidelines

CARD SETS ON SPLYCR

Open a set to host it as a class game, or make a copy to edit.

- Unit 4: Cell Communication (part 1)
- Unit 4: Cell Communication (part 2)

How this was made. The course structure, the activities and the teaching choices come from my own classroom, my presentations and my years of teaching IB and AP Biology. I use Claude, an AI, to help write and build the interactive guides, lesson plans, slides and practice questions, and to draw the diagrams and code the interactives. I direct the work and review it against the IB and AP specifications before it goes live.