NAME _____ CLASS _____ DATE _____

AP BIOLOGY · 4.5 AND 4.6

The cell cycle and its regulation

Notes to fill in alongside the guide. Each numbered block matches a chapter of the guide, and of the lesson slides. Write in the gaps, answer the cues, annotate the figures, and sum up each section in your own words.

BY THE END YOU 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
- [ ] Describe the G1, G2 and M checkpoints, and how cyclins and cyclin-dependent kinases control progress through the cycle 4.6.A
- [ ] Describe how disruptions to the cell cycle can lead to cancer or to apoptosis 4.6.B

01 One cell, two copies 4.5.B

CUES

Predict: 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?

What is meant by parent cell?

What is meant by daughter cells?

What is meant by mitosis?

NOTES

1 The cell that divides is the _____, and it ends as two _____.

2 In eukaryotes, the division that makes body cells is _____.

3 It has one job: to hand a complete copy of the cell's _____, every chromosome, to each of two daughter cells.

4 So the daughters are _____ to each other and to the parent.

5 Organisms use that for three things. _____: you began as one cell and are now tens of trillions. _____: the cells around a wound divide to replace the ones that were lost. _____: a yeast cell budding, a strawberry plant sending out runners or a hydra growing a bud make offspring that are copies of one parent.

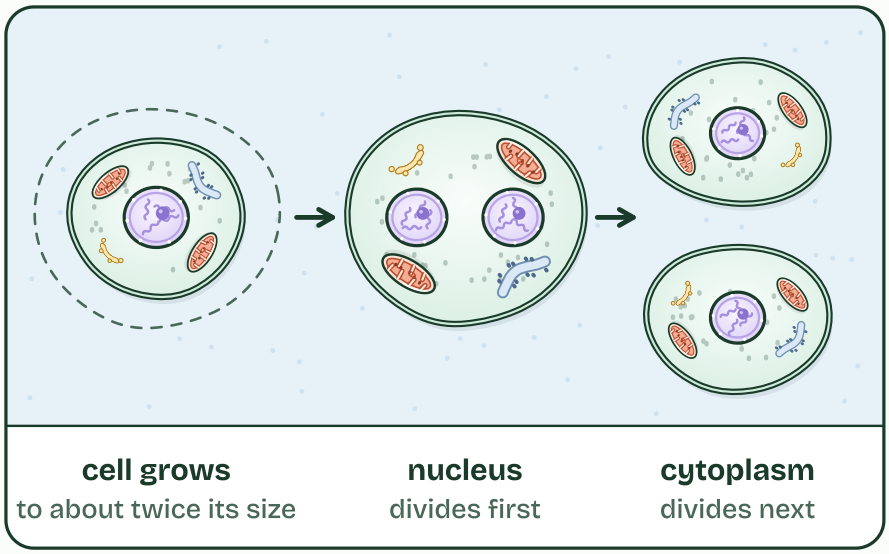
6 _____ passes a complete genome to two genetically identical daughter cells.

What is meant by genome?

Your own notes

ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each: 1 parent cell; 2 nucleus divides; 3 daughter cells.



SPOT THE MISTAKE

What do students often get wrong about why cells divide? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 01 in two or three sentences of your own.

02 Copied, then coiled

4.5.B

CUES

Predict: A cell has 8 chromosomes before it copies its DNA. How many DNA molecules are in its nucleus as mitosis begins?

What is meant by histones?

What is meant by chromatin?

What is meant by chromosome?

What is meant by sister chromatid?

What is meant by centromere?

NOTES

1 The DNA in one of your cells would stretch about two meters if you laid it end to end. It fits into a nucleus a few micrometers across because it is wound around proteins called _____.

2 DNA with its histones is _____, and for most of a cell's life it is spread loosely through the nucleus, where its genes can be read.

3 A _____ is one long DNA molecule with its proteins.

4 The two copies stay joined, and each is now a _____, held to its twin at a narrow region called the _____.

5 Then, as division begins, the chromatin _____: it coils on itself again and again until each chromosome is short and thick enough to be seen in a light microscope.

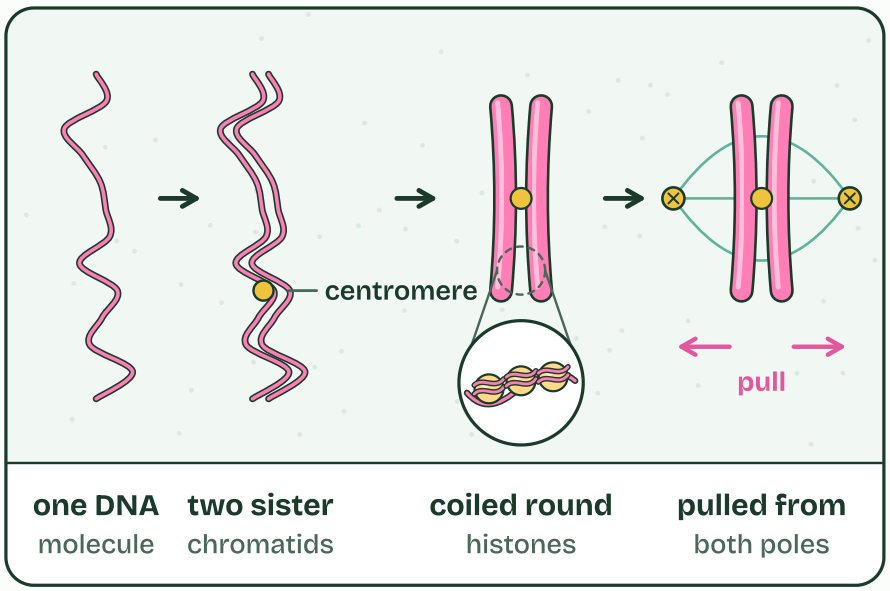
6 A _____ is one DNA molecule wound around histones.

7 After copying, a _____ is two sister chromatids joined at the centromere.

Your own notes

ANNOTATE THE FIGURE

Number the 4 steps on the figure and note what happens at each: 1 one DNA molecule; 2 two sister chromatids; 3 histones; 4 Microtubules.



SPOT THE MISTAKE

What do students often get wrong about chromosomes and chromatids? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 02 in two or three sentences of your own.

03 Around the cycle

4.5.A

CUES

Predict: Compare a cell in G2 with the same cell earlier, in G1. What does it have in G2?

What is meant by cell cycle?

What is meant by interphase?

What is meant by G0?

NOTES

1 A dividing cell goes through the same sequence again and again, the _____.

2 Most of it is _____, in three stages.

3 In _____ the cell grows, making proteins and organelles.

4 In _____ (synthesis) it copies its DNA.

5 In _____ it grows more and makes what it needs to divide.

6 Then comes _____, which divides the nucleus, and _____, which divides the cytoplasm.

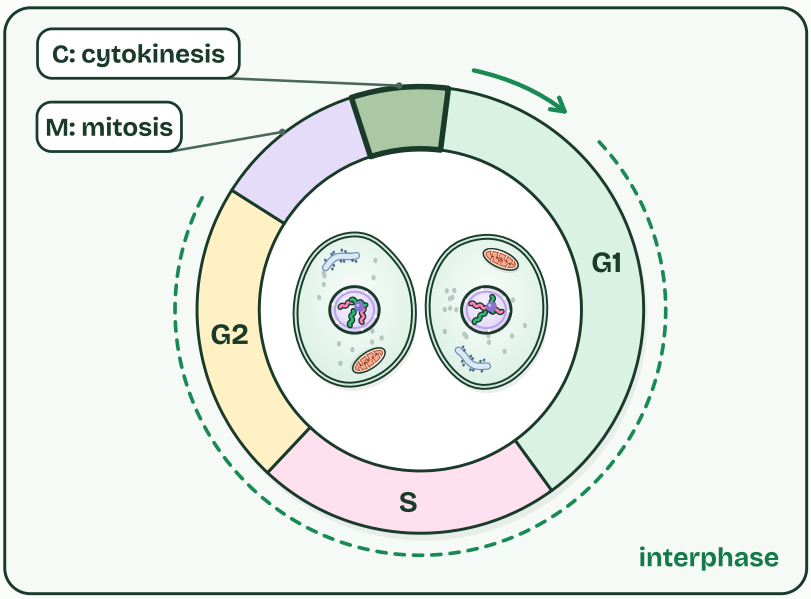
7 A cell can leave the cycle from G1 into _____, where it carries on with its job but does not divide.

8 _____ is G1, S and G2; then mitosis and cytokinesis.

Your own notes

ANNOTATE THE FIGURE

Number the 6 steps on the figure and note what happens at each: 1 cell cycle; 2 G1; 3 S; 4 G2; 5 Mitosis; 6 Cytokinesis.



REMEMBER IT

The order of the cycle: Giraffes Sing, Gorillas Make Chili

G Giraffes	S Sing	G Gorillas	M Make	C Chili
G	S	G	M	C

SPOT THE MISTAKE

What do students often get wrong about the cell cycle? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 03 in two or three sentences of your own.

04 A complete genome, twice

4.5.B

CUES

Predict: A dog's body cells have 78 chromosomes. A skin cell divides by mitosis. How many chromosomes does each daughter cell have?

What is meant by spindle?

NOTES

1 The cell builds a _____ of microtubules from two poles, attaches every chromosome to both poles, lines them all up, and then pulls the two chromatids of each chromosome in opposite directions.

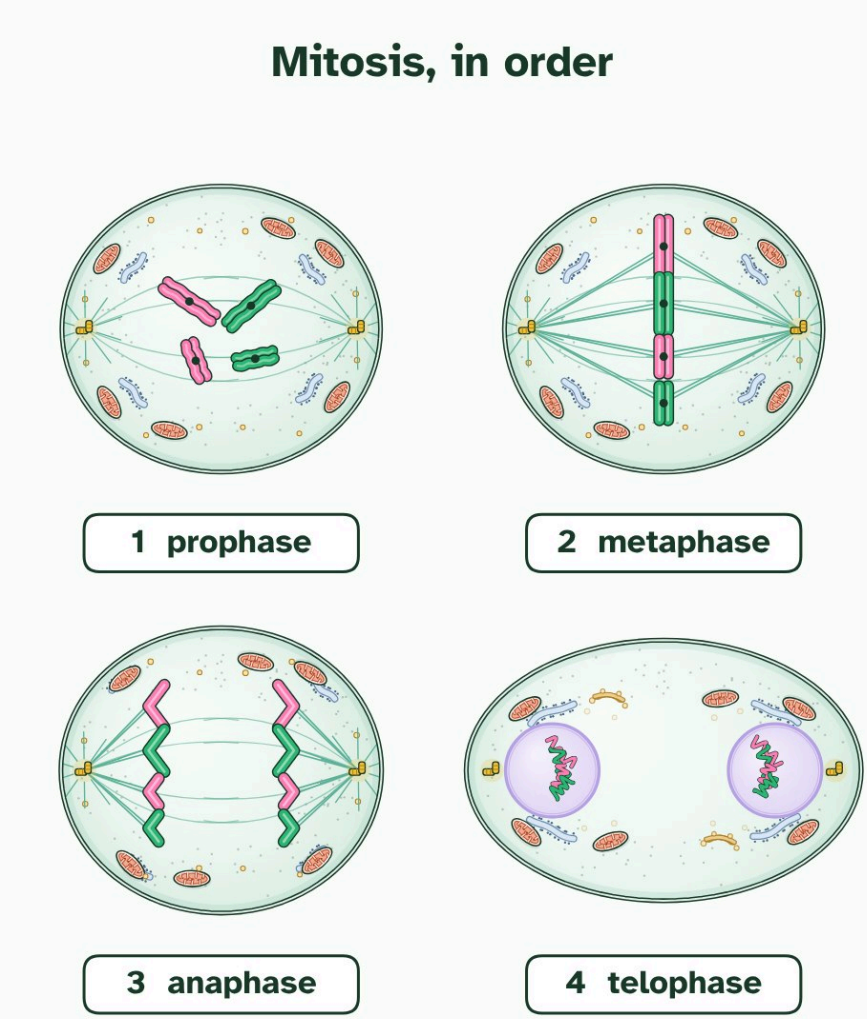
2 That is why mitosis gives _____ nuclei.

3 A _____ attaches every chromosome to both poles.

Your own notes

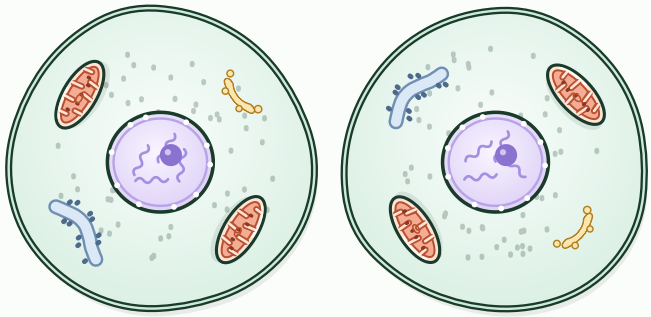
ANNOTATE THE FIGURE

Annotate this still from the animation (Mitosis, one phase at a time): what is happening, and why?



ANNOTATE THE FIGURE

Label the key parts and add a note on what it shows.



one cell, then two

SPOT THE MISTAKE

What do students often get wrong about mitosis? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 04 in two or three sentences of your own.

05 Four phases, one at a time

4.5.B

CUES

Predict: The drug colchicine stops microtubules forming. Root tip cells are soaked in it for a few hours. Where do the dividing cells get stuck?

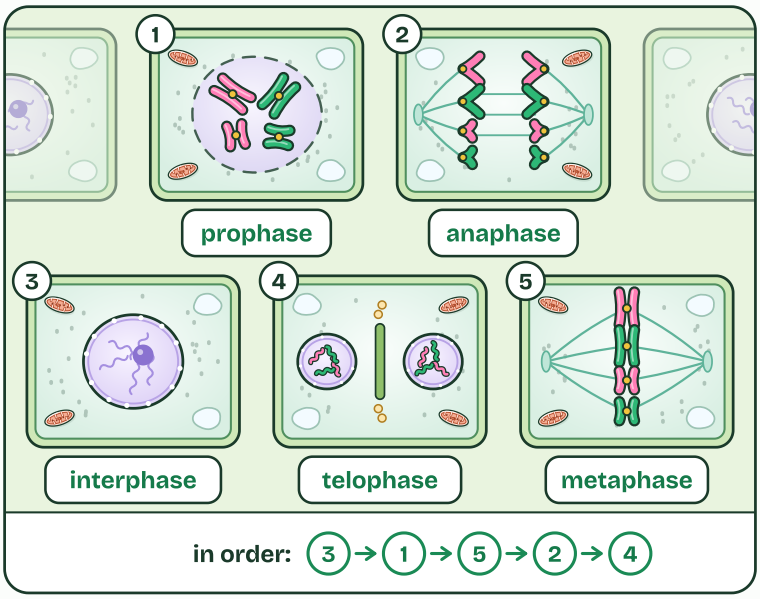
NOTES

1. The nuclear envelope breaks down, and the spindle starts to grow from the two poles. _____ Microtubules from both poles attach at each centromere, and the chromosomes line up in a single row across the middle of the cell. _____ The centromeres split and the sister chromatids are pulled to opposite poles; from this moment, each chromatid counts as a chromosome of its own. _____ A nuclear envelope forms around each group, the chromosomes uncoil and the spindle breaks down.
2. Prophase: _____.
3. Anaphase: _____.
4. Five drawn cells from a root tip. _____ before you go on.
5. _____: a round nucleus and a dark nucleolus.
6. _____: thick threads, the nuclear envelope going.

Your own notes

ANNOTATE THE FIGURE

Number the 7 steps on the figure and note what happens at each.



REMEMBER IT

The four phases, in order: Penguins March Across Town

P Penguins	M March	A Across	T Town
P	M	A	T

SPOT THE MISTAKE

What do students often get wrong about the phases of mitosis? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 05 in two or three sentences of your own.

06 Splitting the cytoplasm

4.5.A

CUES

Predict: A drug stops actin filaments forming but leaves microtubules alone. What happens when an animal cell treated with it divides?

What is meant by cytokinesis?

What is meant by cleavage furrow?

What is meant by cell plate?

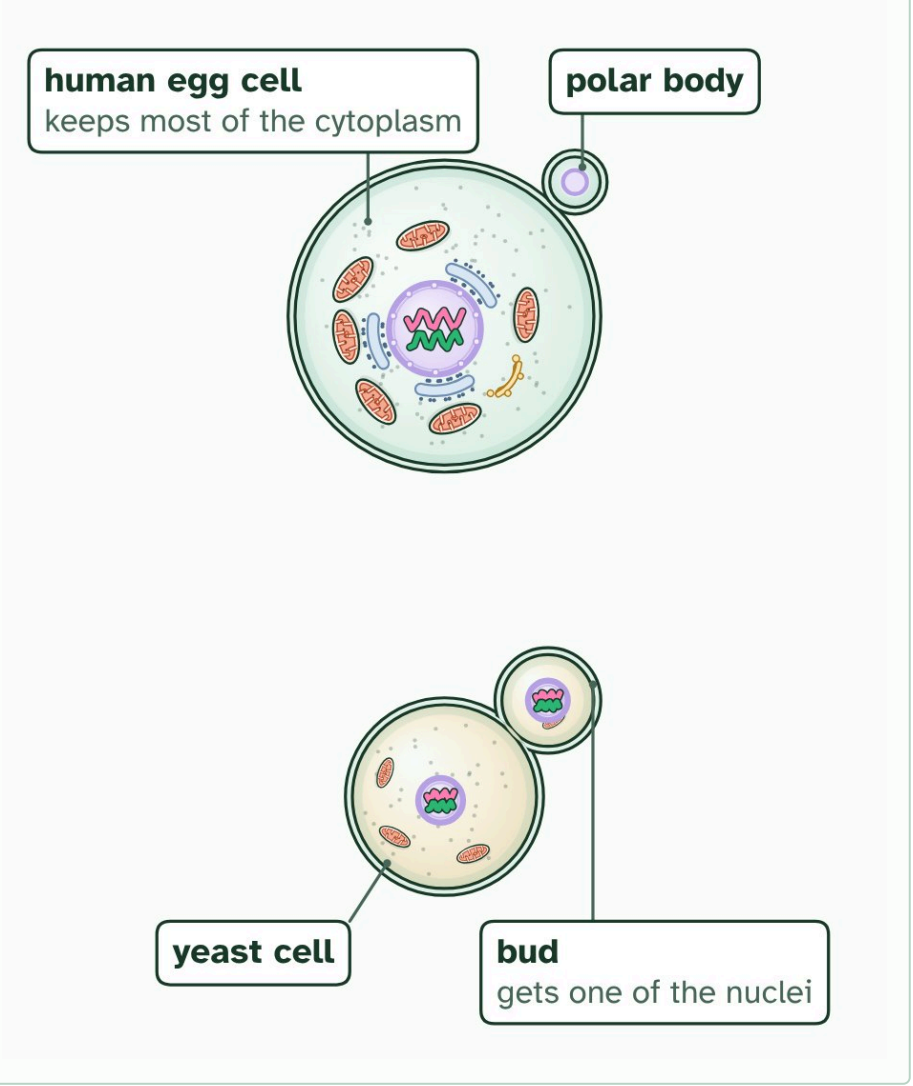
NOTES

1. Mitosis leaves one cell with two nuclei. _____ finishes the job by dividing the cytoplasm, usually starting while telophase is still under way.
2. In an _____, a ring of actin and myosin filaments forms just inside the membrane around the middle of the cell.
3. The ring tightens like a drawstring, and the membrane is pulled in to make a groove, the _____, until the cell is pinched in two.
4. A _____ cannot be pinched, because its wall will not bend.
5. Instead, vesicles from the Golgi carry membrane and wall material to the middle of the cell and fuse into a flat _____.
6. Mitosis divides the nucleus; _____ divides the cytoplasm.
7. Animal cells: a ring of actin and myosin makes a _____.
8. Plant cells: vesicles fuse into a _____ that becomes a new wall.

Your own notes

ANNOTATE THE FIGURE

Annotate this still from the animation (Splitting the cytoplasm): what is happening, and why?



SPOT THE MISTAKE

What do students often get wrong about cytokinesis? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 06 in two or three sentences of your own.

07 Stop, or go

4.6.A

CUES

Predict: A cell makes a mutant cyclin, the kind that drives mitosis, that cannot be broken down. What would you expect?

What is meant by checkpoints?

What is meant by cyclin-dependent kinases?

What is meant by cyclin?

NOTES

1 At _____ it checks its own state and goes on only if all is well.

2 The _____ asks whether the cell is big enough, has the nutrients and signals it needs, and has undamaged DNA; a cell that fails it may wait or move into G0.

3 The _____ asks whether all the DNA has been copied, without damage.

4 The _____, or spindle checkpoint, in metaphase, holds off anaphase until every chromosome is attached to the spindle from both poles.

5 The go signals are two kinds of protein working as a pair. _____ (CDKs) are present all the time, but a CDK on its own is inactive.

6 It works only when bound to a _____, and cyclins come and go: each kind is made through part of the cycle and then broken down.

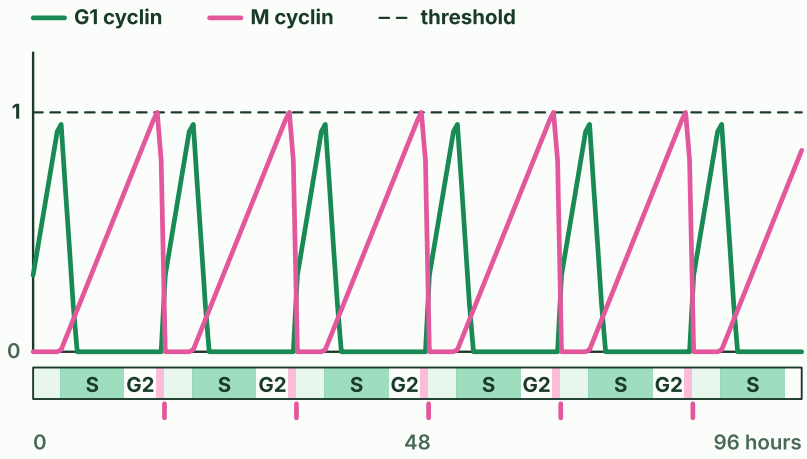
7 _____ at G1, G2 and M let the cell go on only when conditions are right.

8 A _____ activates its CDK, which phosphorylates proteins that drive the next stage.

Your own notes

ANNOTATE THE FIGURE

Number the 3 steps on the figure and note what happens at each: 1 threshold, checkpoint; 2 G1; 3 oncogene.



REMEMBER IT

What each checkpoint checks

G Grown?	G Genome copied?	M Moored?
G	G	M

SPOT THE MISTAKE

What do students often get wrong about checkpoints, cyclins and CDKs? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 07 in two or three sentences of your own.

08 When cells ignore the rules

4.6.B

CUES

Predict: A skin cell's DNA is badly damaged by sunlight and cannot be repaired. For the rest of the body, what is the best thing that cell can do?

What is meant by proto-oncogenes?

What is meant by oncogene?

What is meant by tumor suppressor genes?

What is meant by cancer?

What is meant by apoptosis?

NOTES

1 Two kinds of gene keep the cycle under control. _____ make proteins that push a cell to divide when it is signaled to.

2 A mutation can turn one into an _____, stuck on like an accelerator taped down. _____ make the brakes: proteins that hold a cell at a checkpoint when its DNA is damaged.

3 _____ is cells that divide when they should not and pass checkpoints they should fail.

4 The planned alternative is _____.

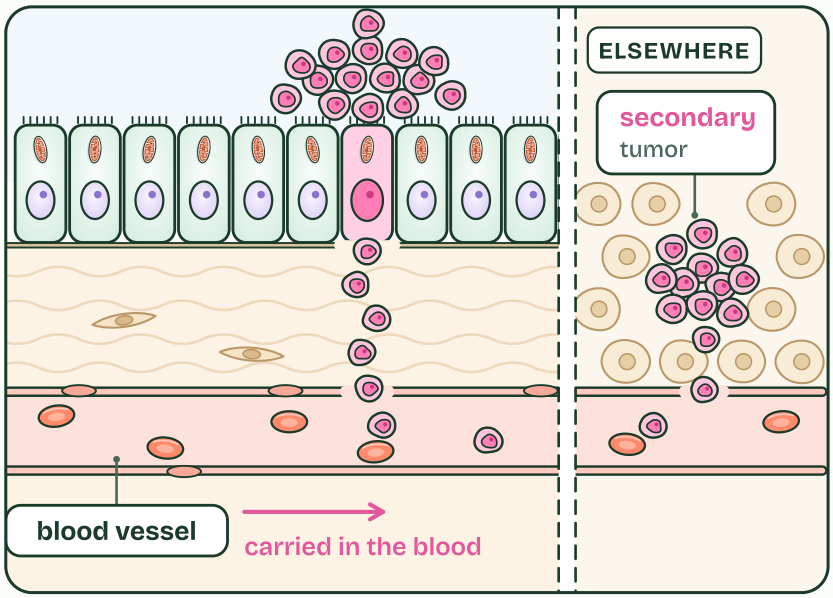
5 _____ usually takes several mutations, in both kinds of gene.

6 _____ removes damaged or unneeded cells in an orderly way.

Your own notes

ANNOTATE THE FIGURE

Number the 5 steps on the figure and note what happens at each.



SPOT THE MISTAKE

What do students often get wrong about disruptions to the cell cycle? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 08 in two or three sentences of your own.

Check yourself

The check for this guide is online: a fresh paper of past-paper style questions from the exam bank on 4.5 and 4.6 each time, marked as you go, and saved to your Exam practice progress when you are signed in. Scan the code, or type the link.

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

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.