NAME _____ CLASS _____ DATE _____

IB BIOLOGY · D2.1

Cell and nuclear division

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

- [ ] Outline how new cells are made by a parent cell dividing into two daughter cells D2.1.1
- [ ] Compare cytokinesis in animal cells and plant cells D2.1.2
- [ ] Explain why cytokinesis is usually equal, give two examples of unequal cytokinesis, and say what every daughter cell must receive D2.1.3
- [ ] Explain why nuclear division comes before cell division, and the different roles of mitosis and meiosis D2.1.4
- [ ] Explain why DNA replication must happen before mitosis or meiosis, and what a chromosome is made of afterwards D2.1.5
- [ ] Outline how chromosomes condense and how they are moved D2.1.6
- [ ] Describe the phases of mitosis and explain how mitosis produces genetically identical nuclei D2.1.7
- [ ] Identify the phases of mitosis in diagrams and micrographs D2.1.8
- [ ] Explain meiosis as a reduction division, using the terms diploid and haploid D2.1.9
- [ ] Explain how non-disjunction can cause Down syndrome D2.1.10
- [ ] Explain how random orientation and crossing over make meiosis a source of variation D2.1.11
- [ ] Outline cell proliferation for growth, cell replacement and tissue repair D2.1.12
- [ ] Describe the phases of the cell cycle and what happens during interphase D2.1.13
- [ ] Outline the growth that happens in interphase, including organelles D2.1.14
- [ ] Explain how rising and falling cyclin concentrations control the cell cycle D2.1.15
- [ ] Explain how mutations in proto-oncogenes and tumour suppressor genes can lead to uncontrolled division D2.1.16
- [ ] Distinguish benign and malignant tumours, and primary and secondary tumours, and determine a mitotic index D2.1.17

01 One cell becomes two

D2.1.1

CUES

Predict: Why does a eukaryotic cell divide its nucleus before it divides its cytoplasm?

What is meant by parent cell?

NOTES

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

2 A _____ divides to give two daughter cells.

3 A _____ grows to about twice its starting size.

4 Its _____ first, so there are two.

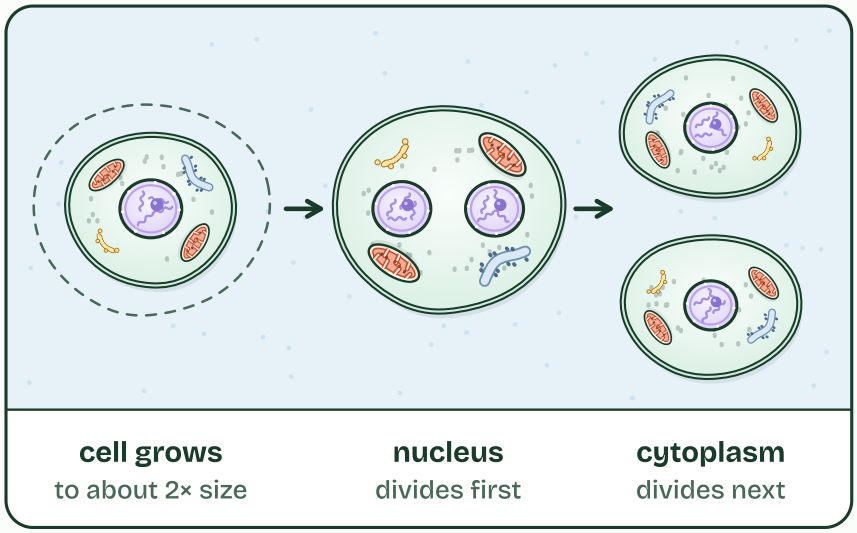
5 Then the cytoplasm divides: two _____, each with a nucleus.

What is meant by daughter cells?

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 generation of new cells by cell division? 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 Splitting the cytoplasm

D2.1.2 D2.1.3

CUES

Predict: In a human egg cell's last division, why might keeping almost all the cytoplasm in one cell be an advantage?

What is meant by cytokinesis?

What is meant by cell plate?

NOTES

1 _____ splits the cytoplasm once the nucleus has divided.

2 In an _____, a ring of the proteins actin and myosin forms just inside the membrane around the middle of the cell.

3 In a _____, the wall cannot be pinched.

4 They make a _____, which grows outwards to the side walls and becomes the two new membranes with a new wall between them.

5 Cytokinesis is usually _____, but not always.

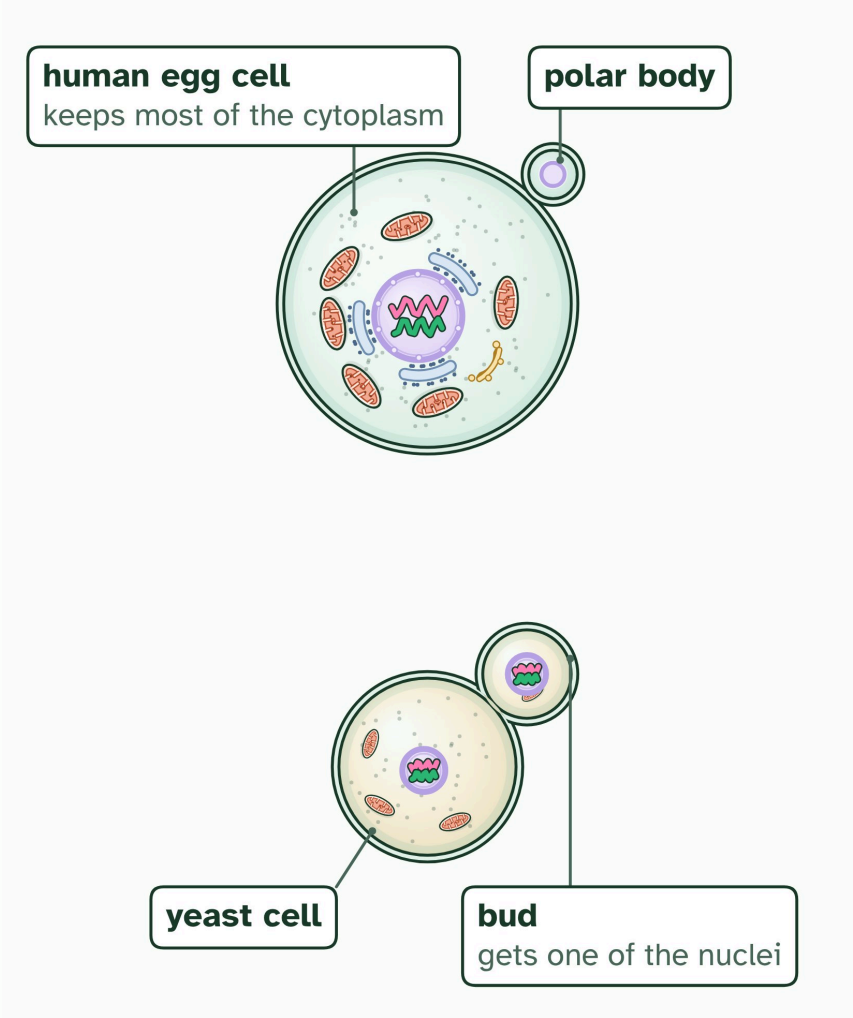
6 In human _____ production the cytoplasm is divided very unequally: the egg keeps almost all of it and a tiny _____ is pinched off. _____ divides by _____: a small bud grows out of the cell, takes one nucleus and pinches off.

7 Plant cells: vesicles fuse into a _____, which becomes the new membranes and 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, equal and unequal? 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 Copy, coil, move

D2.1.4 D2.1.5 D2.1.6

CUES

Predict: A cell has 8 chromosomes in G1. How many DNA molecules does its nucleus hold at the start of mitosis?

What is meant by mitosis?

What is meant by meiosis?

What is meant by sister chromatids?

What is meant by centromere?

What is meant by histones?

What is meant by microtubules?

NOTES

1 Eukaryotes divide their nucleus in one of two ways. _____ gives two nuclei with the same chromosome number and the same genome as the parent, for growth, repair and asexual reproduction. _____ halves the chromosome number and makes every nucleus genetically different, for making gametes.

2 Until then each chromosome is one long DNA molecule; afterwards it is two identical molecules, the _____, held together at the _____ until anaphase.

3 The chromosomes _____: each DNA molecule winds round _____ and then coils on itself again and again (supercoiling), so that metres of DNA become short, thick chromosomes that can be moved without tangling.

4 And they are _____ by _____ of the spindle, pulled by motor proteins.

5 _____ keeps the chromosome number and genome; meiosis halves the number and makes variety.

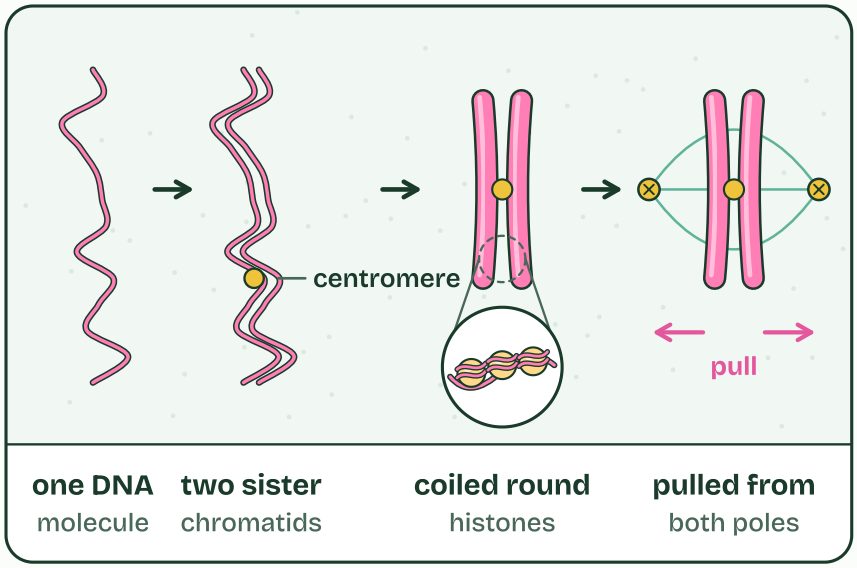
6 DNA is replicated first: each chromosome becomes two _____ joined at the centromere.

7 Chromosomes condense by supercoiling round _____; microtubules and motor proteins move them.

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 mitosis and meiosis; replication; condensing and moving chromosomes? 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 Four phases, two identical nuclei

D2.1.7

CUES

Predict: In a cell in metaphase, what are lined up on the equator?

What is meant by equator?

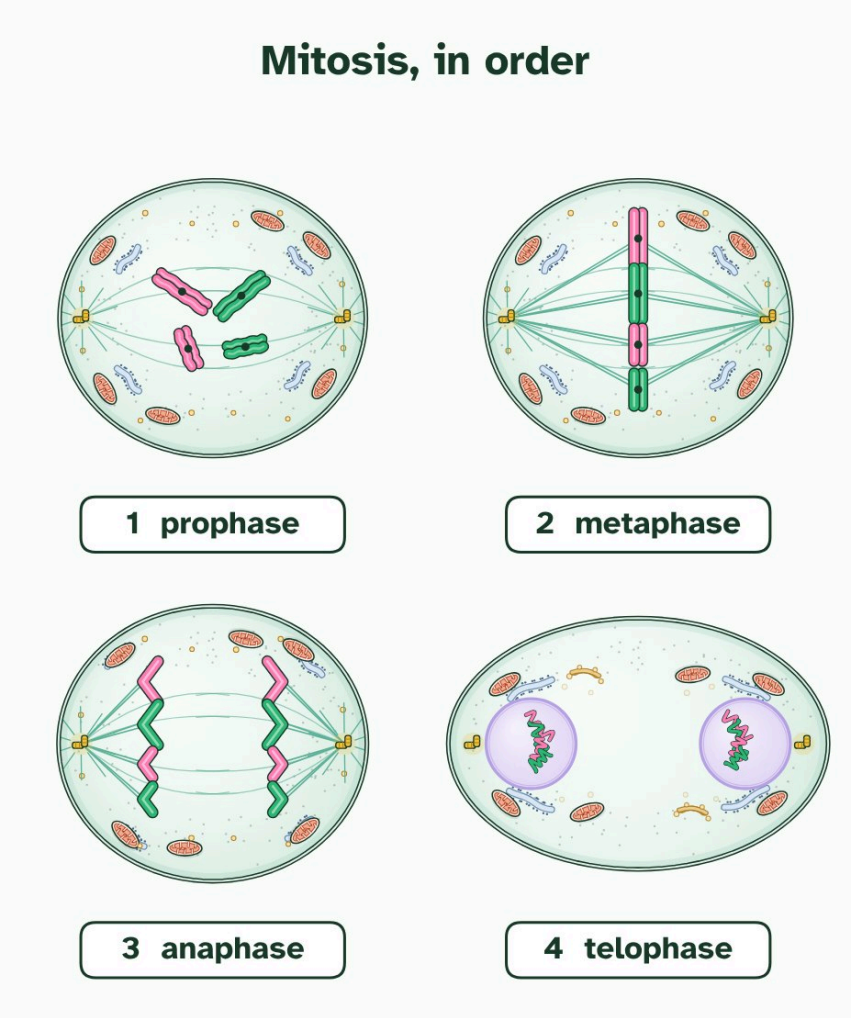
NOTES

1. In _____ the chromosomes condense and become visible, the nuclear membrane breaks down, and the spindle starts to form from the two poles.
2. In _____ microtubules from both poles attach to each centromere and the chromosomes line up across the _____.
3. In _____ the centromeres separate and the sister chromatids are pulled to opposite poles, so each is now a chromosome in its own right.
4. In _____ a nuclear membrane forms round each group, the chromosomes uncoil and the spindle breaks down.
5. The result is two nuclei that are _____ to each other and to the parent nucleus.

Your own notes

ANNOTATE THE FIGURE

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



REMEMBER IT

Make your own

P	M	A	T
P	M	A	T

SPOT THE MISTAKE

What do students often get wrong about phases of 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 Name the phase

D2.1.8

CUES

Predict: In a root tip squash most cells are in interphase, and of the dividing cells more are in prophase than in anaphase. What does this tell you?

NOTES

1 _____: a round nucleus with a darker nucleolus and no separate chromosomes. _____: threads inside the nucleus, getting thicker; the nucleus may lose its edge. _____: a band of chromosomes straight across the middle of the cell. _____: two groups moving to opposite ends, often in V shapes with their arms trailing. _____: two groups at the ends, often with a new nucleus forming round each and a cell plate between them.

2 Interphase: _____.

3 Five drawn cells from a root tip. _____ before you go on.

4 _____: a round nucleus and a dark nucleolus.

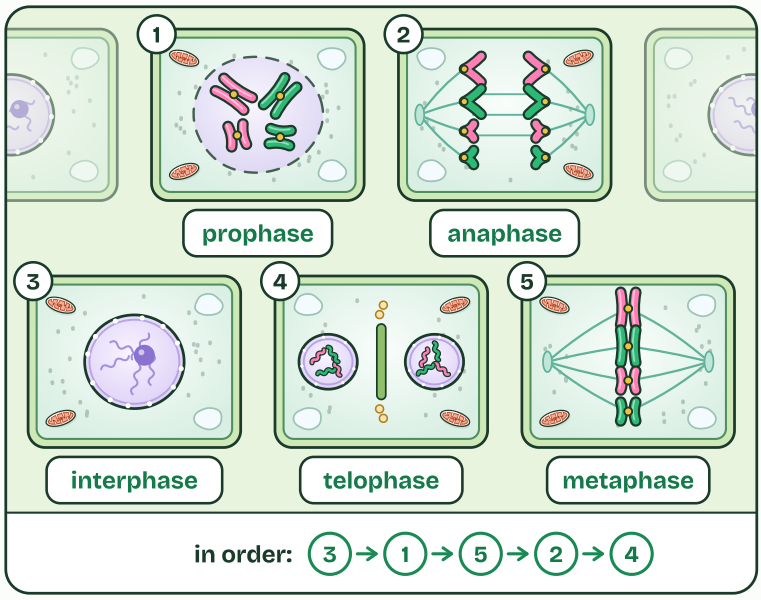
5 _____: thick threads, the nuclear membrane going.

6 _____: chromosomes in a line across the middle.

Your own notes

ANNOTATE THE FIGURE

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



SPOT THE MISTAKE

What do students often get wrong about identification of 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 Meiosis halves the number

D2.1.9

CUES

Predict: A horse has 64 chromosomes in its body cells. How many are in a horse sperm cell, and how many in a cell after meiosis I?

What is meant by diploid?

What is meant by haploid?

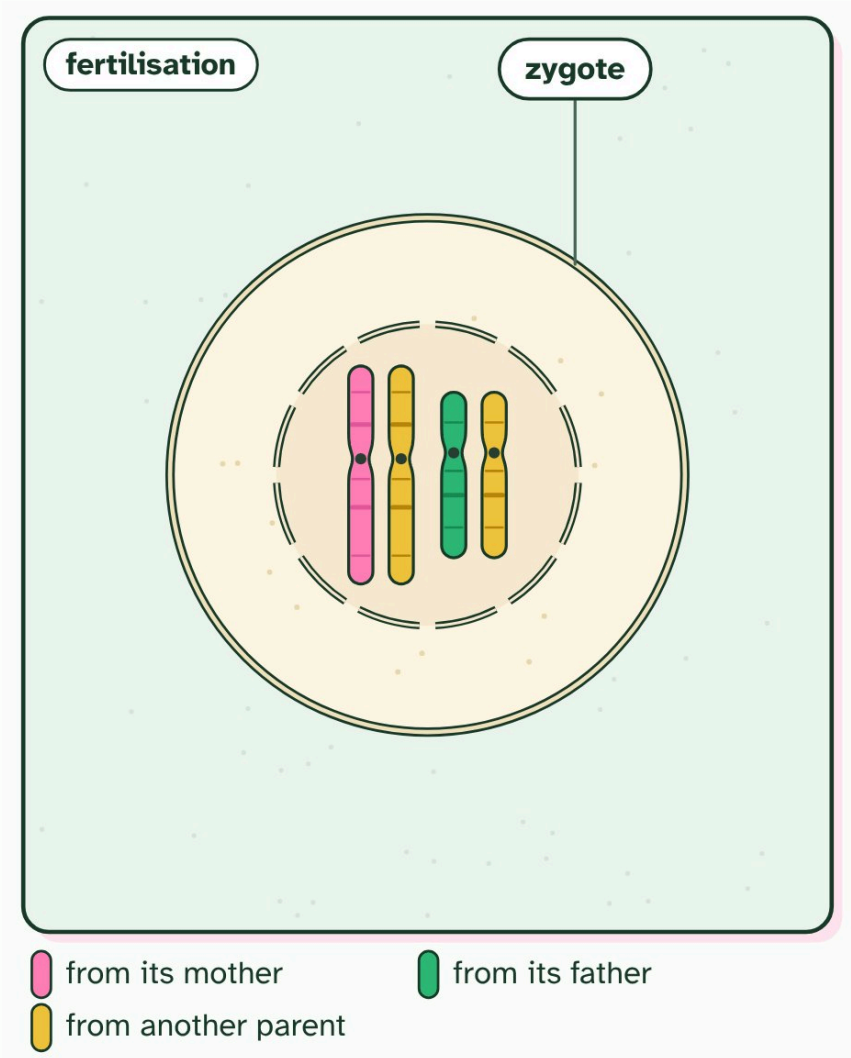
NOTES

1. A _____ cell has two sets of chromosomes, one from each parent: in humans, 23 pairs, so 2n = 46.
2. A _____ cell has one set, n = 23.
3. In _____ the homologous chromosomes pair up and then separate, one of each pair to each pole: this is the halving, the first round of segregation.
4. In _____ the sister chromatids of each chromosome separate, as in mitosis: the second round.
5. One diploid nucleus becomes _____.
6. _____ (2n): two sets of chromosomes. Haploid (n): one set.
7. One _____ nucleus gives four haploid nuclei; fertilisation restores diploid.

Your own notes

ANNOTATE THE FIGURE

Annotate this still from the animation (Halving, then fusing): what is happening, and why?



SPOT THE MISTAKE

What do students often get wrong about meiosis as a reduction division? 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 One chromosome too many

D2.1.10

CUES

Predict: Non-disjunction of chromosome 21 happens in meiosis I in a father. What fraction of the sperm made from that cell would give trisomy 21 if they fertilised a normal egg?

What is meant by non-disjunction?

NOTES

1 In _____, a pair of chromosomes fails to separate in meiosis I, or the two chromatids of one chromosome fail to separate in meiosis II.

2 If a gamete with two copies of chromosome 21 is fertilised by a normal gamete, the zygote has three: _____, 47 chromosomes in every cell of the body that grows from it.

3 This causes _____, with a range of effects including learning difficulties, a characteristic facial appearance and a higher chance of heart problems.

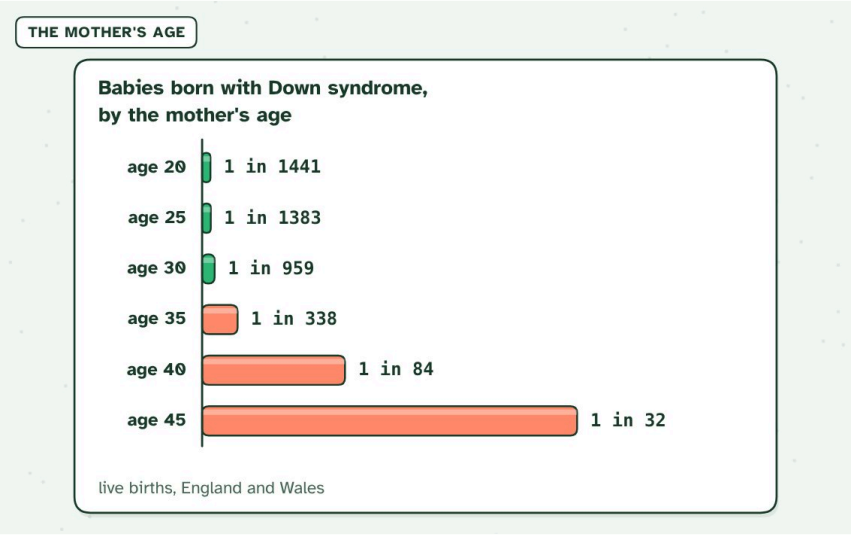
4 A karyotype of a fetus can be made from cells taken in pregnancy, by _____ (a small sample of the placenta, from about 11 weeks) or _____ (fluid from around the fetus, from about 15 weeks).

5 _____: chromosomes or chromatids fail to separate in meiosis.

Your own notes

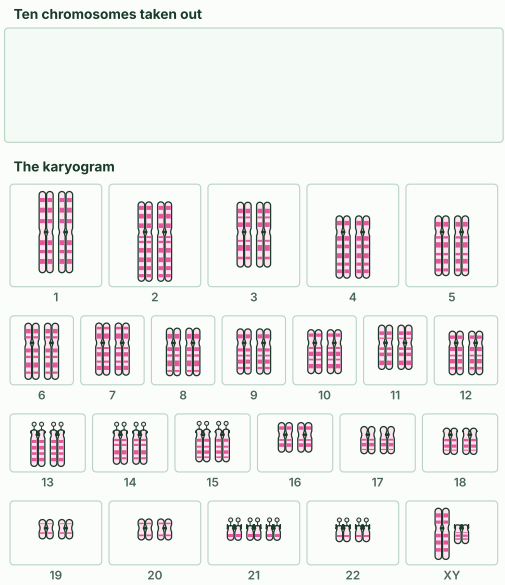
ANNOTATE THE FIGURE

Annotate this still from the animation (One pair that did not separate): what is happening, and why?



ANNOTATE THE FIGURE

Number the 2 steps on the figure and note what happens at each: 1 length, centromere position, bands; 2 47.



SPOT THE MISTAKE

What do students often get wrong about down syndrome and non-disjunction? 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 Every gamete different

D2.1.11

CUES

Predict: A fruit fly has 4 pairs of chromosomes. Ignoring crossing over, how many kinds of gamete can random orientation give?

What is meant by bivalent?

NOTES

1 The first is _____.

2 In metaphase I each pair of homologous chromosomes (a _____) lines up on the equator with either chromosome facing either pole, and each pair does so independently of the others.

3 The second is _____.

4 Or the long pair the other way round. Each pair lines up _____.

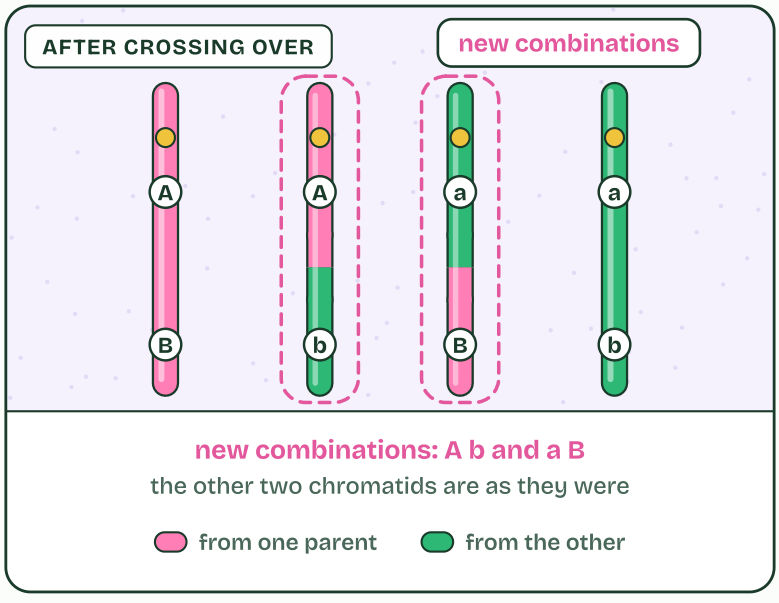
5 So there are four kinds of gamete: _____.

6 In prophase I, chromatids of a pair can break and _____.

Your own notes

ANNOTATE THE FIGURE

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



REMEMBER IT

Two sources of variety in meiosis

S Shuffle	S Swap
S	S

SPOT THE MISTAKE

What do students often get wrong about meiosis as a source of variation? 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.

09 Growth, repair and the cycle

D2.1.12 HL D2.1.13 HL D2.1.14 HL

CUES

Predict: A cell is in G2. Compared with the same cell in G1, what does it have?

What is meant by cell cycle?

NOTES

1 A plant grows from its _____, regions at the tips of roots and shoots where cells keep dividing.

2 Proliferation uses the _____. _____ is made of three stages: G1, when the cell grows; S, when the DNA is replicated; and G2, when it grows further and prepares to divide.

3 Then come _____ and _____.

4 Proliferation: _____.

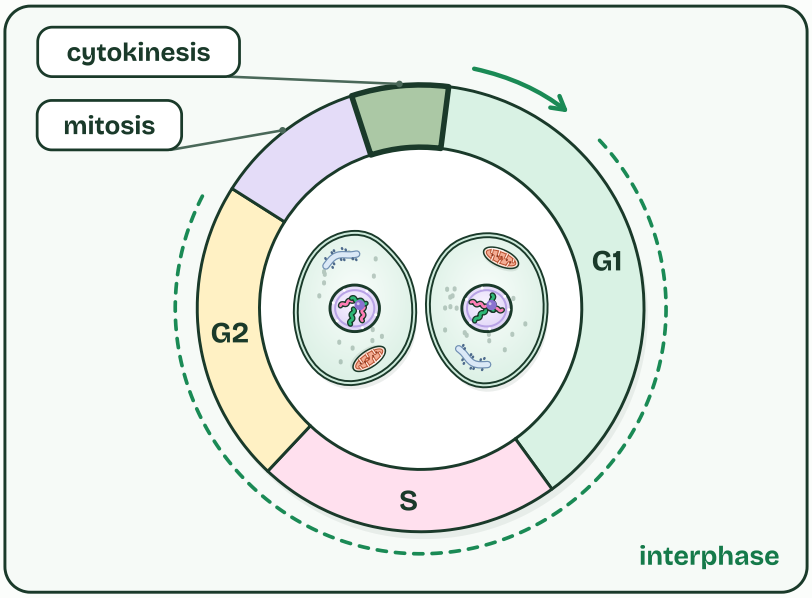
5 The cycle: _____.

6 Interphase is busy: _____.

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.



SPOT THE MISTAKE

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

The mistake

Put it right

SUMMARY

Sum up section 09 in two or three sentences of your own.

10 Cyclins open the gates

D2.1.15 HL

CUES

Predict: A drug stops the M cyclin from being broken down after the cell enters mitosis. What would you expect?

What is meant by checkpoints?

What is meant by cyclins?

NOTES

1 At _____, such as the end of G1 and the end of G2, it goes on only when conditions are right.

2 The signals that let it through are proteins called _____.

3 When a particular cyclin reaches a _____ concentration, the cell passes the checkpoint that cyclin controls.

4 A normal cell: each cyclin rises to its _____, the cell passes that _____, and the cyclin is broken down. Four divisions in four days.

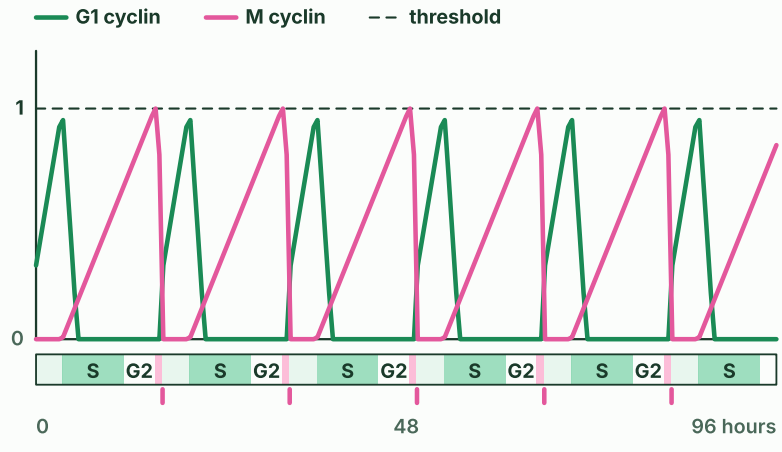
5 No growth signal: the G1 cyclin is never made, so the cell stays in _____ and does not divide.

6 An _____: the G1 cyclin builds up fast with no signal at all, so the cell divides again and again.

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.



SPOT THE MISTAKE

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

The mistake

Put it right

SUMMARY

Sum up section 10 in two or three sentences of your own.

11 When control fails

D2.1.16 HL D2.1.17 HL

CUES

Predict: In a field of view of 250 cells from a tumour, 30 are in mitosis. What is the mitotic index?

What is meant by proto-oncogenes?

What is meant by oncogene?

What is meant by tumour suppressor genes?

What is meant by mitotic index?

NOTES

1 Two kinds of gene control the cycle. _____ code for proteins that push the cell to divide when it is signalled to.

2 A mutation can turn one into an _____, which drives division all the time, like an accelerator stuck down.

_____ code for proteins that stop the cycle, for example when DNA is damaged.

3 Uncontrolled division forms a _____.

4 A _____ tumour grows slowly and stays where it formed, often inside a capsule; it does not cause cancer, though it can still press on organs.

5 A _____ tumour divides faster, invades the tissue around it and can spread: cells break away, travel in the blood or lymph, and grow into _____ elsewhere (metastasis).

6 How fast cells divide can be measured with the _____: the cells in mitosis as a proportion of all the cells in a field of view.

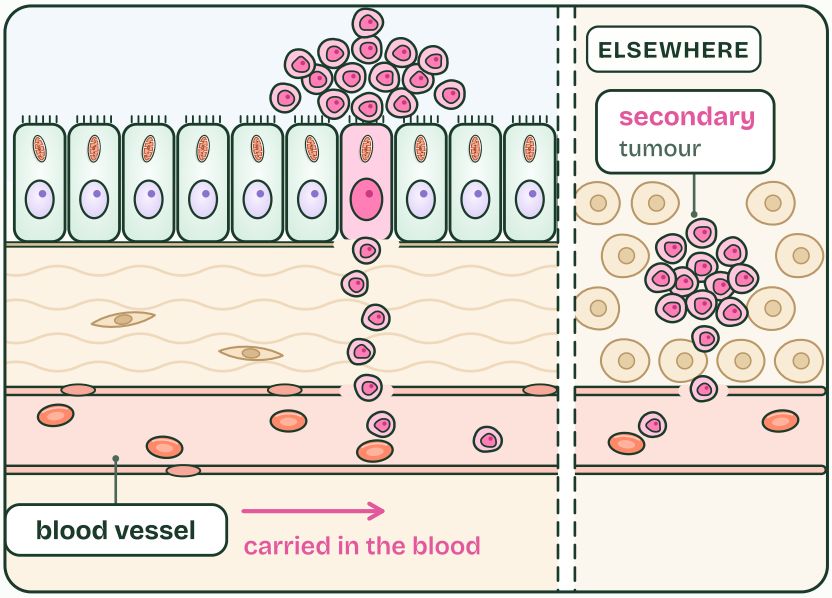
7 Proto-_____ mutated to oncogene: division stimulated. Tumour suppressor lost: division not stopped.

8 _____ = cells in mitosis / total cells.

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 mutations in cycle genes; tumours? Write the mistake, then put it right.

The mistake

Put it right

SUMMARY

Sum up section 11 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 D2.1 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?topics=D2.1&level=HL&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.