

Comparing Cells

A Level

C

C

C

Part A

Bacteria vs sperm cells

Which of the following statements are correct for both bacterial cells and sperm cells? Select all that apply.

- ☐ The cell has a cell wall.
- ☐ The cell has a nucleus.
- ☐ The cell contains DNA.
- ☐ The cell can divide.
- ☐ The cell can carry out respiration.

Part B Blood, kidney, or testis?

Three samples of cells were taken from the same healthy human: one sample from the blood, one sample from a kidney, and one sample from a testis.

Each sample contained five cells, three of one type and two of a different type. None of the cells were dividing.

In each sample, the mean number of chromosomes per cell was calculated. The results are shown in the table below.

Match the sample to the tissue type.

Sample	Mean number of chromosomes per cell	Tissue
1	18.4	<input type="text"/>
2	32.2	<input type="text"/>
3	46.0	<input type="text"/>

Items:

- blood
- testis
- kidney

In the blood sample above, how many of the cells were red blood cells?

In the testis sample above, how many of the cells were sperm cells?

Part C Cell types and genes

A student compared the properties of different cells from one healthy human.

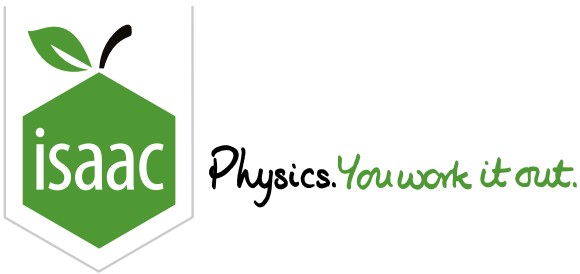
Which of the following statements are correct? Select all that apply.

Assume that no mutations occur.

- ☐ A sperm cell contains the same genome as a cheek cell.
 - ☐ An embryonic stem cell produces all of the same proteins as a white blood cell.
 - ☐ A white blood cell contains the same number of DNA bases as a mature red blood cell.
 - ☐ A cheek cell contains the same alleles as an embryonic stem cell.
-

Question elements adapted with permission from NSAA 2019 Section 1 Q55, NSAA 2020 Section 2 Q54, and NSAA 2021 Section 1 Q79

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Membrane Concentration Gradients

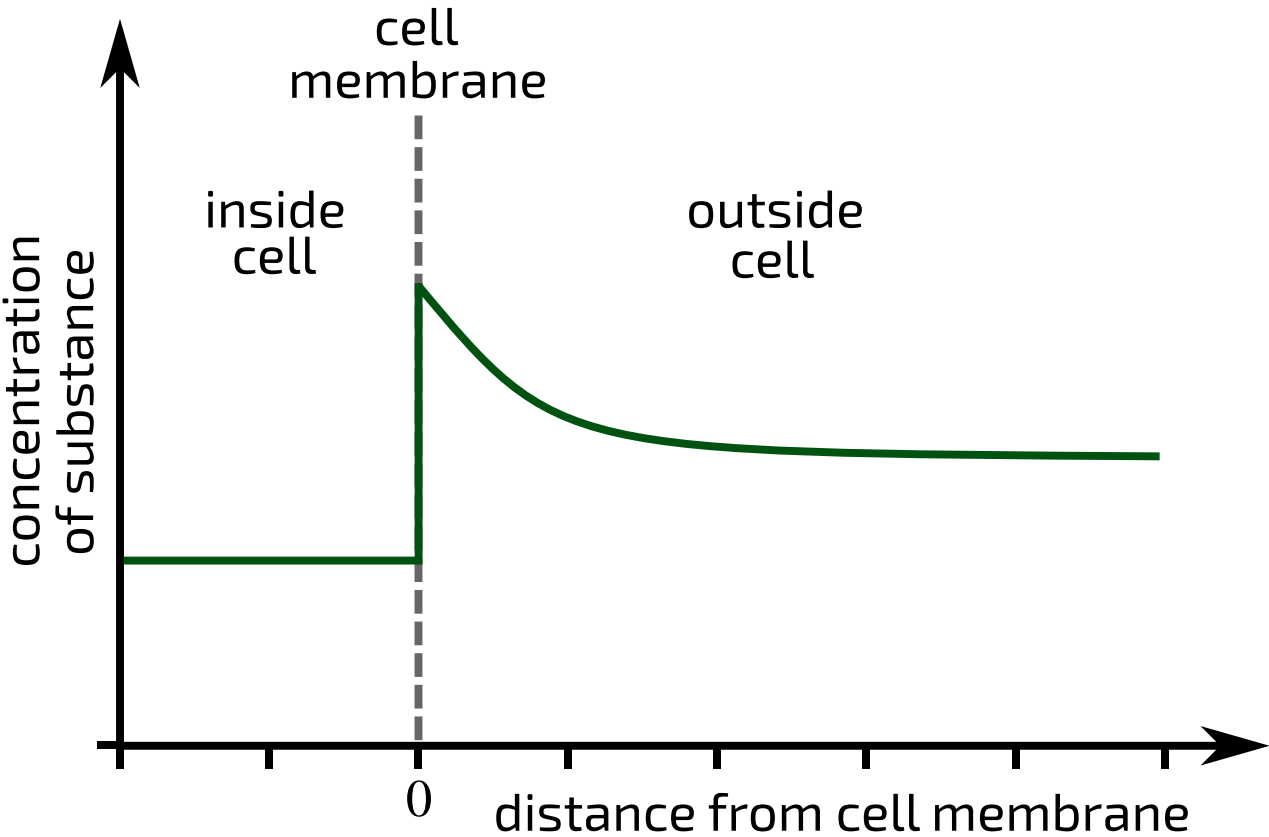
A Level

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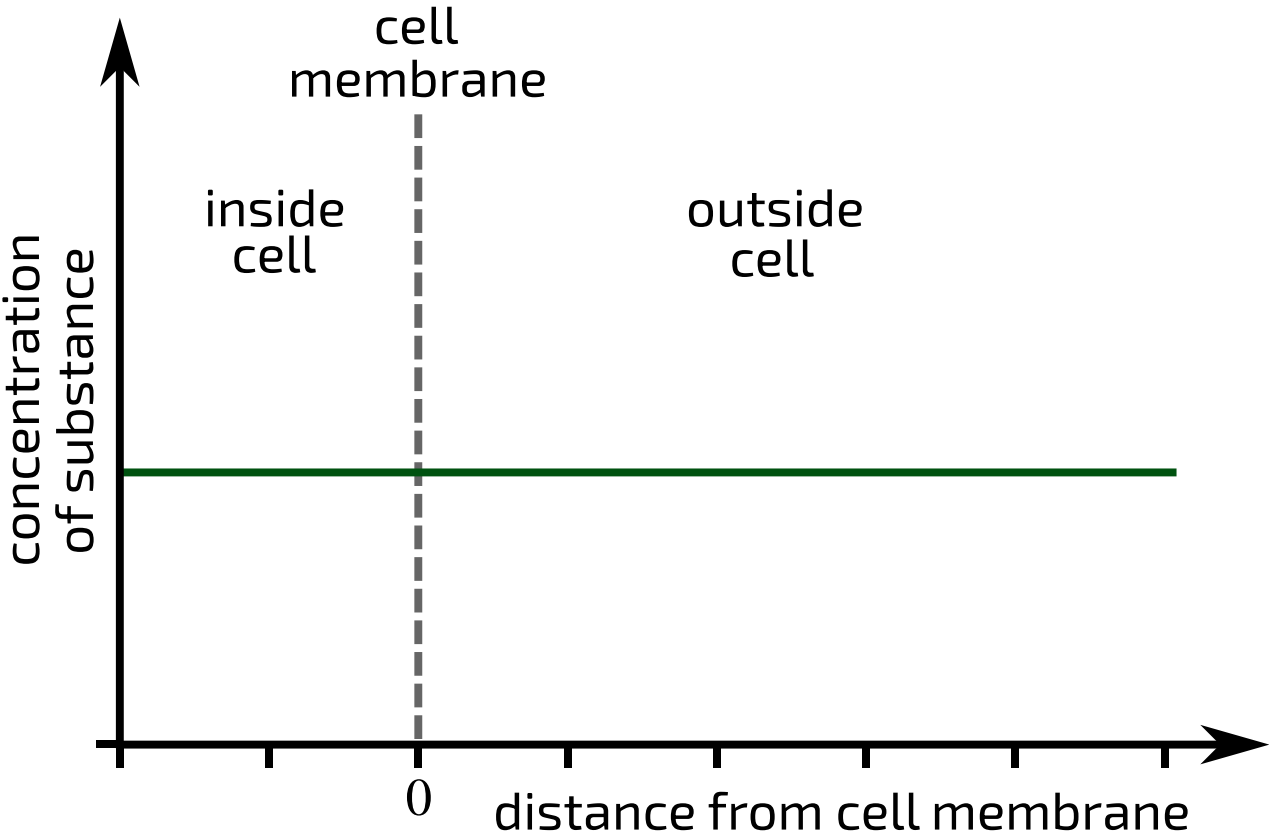
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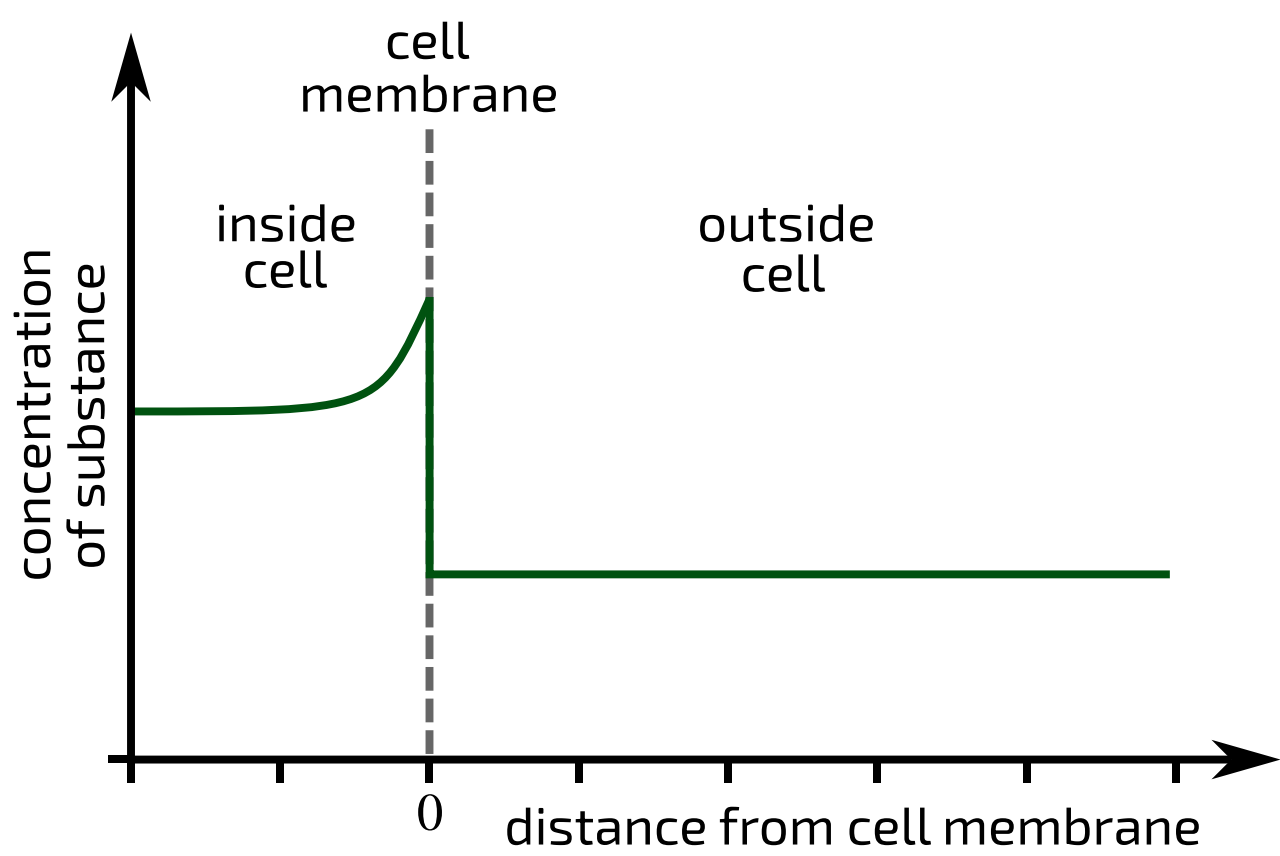
The graphs below show the concentrations of substances at different distances from the cell membrane. The concentrations shown are maintained over time.



A



B



C

Part A Active transport

Which of the images above show the concentration of a substance that moves across the membrane by active transport?

- ☐ A
- ☐ B
- ☐ C

Part B Passive transport

Which of the images above show the concentration of a substance that moves across the membrane by passive transport?

☐ A

☐ B

☐ C

Part C Forms of passive transport

Which of the following are forms of passive transport?

☐ Primary active transport

☐ Simple diffusion

☐ Osmosis

☐ Secondary active transport

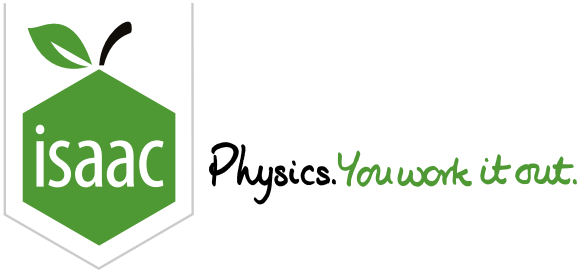
☐ Facilitated diffusion

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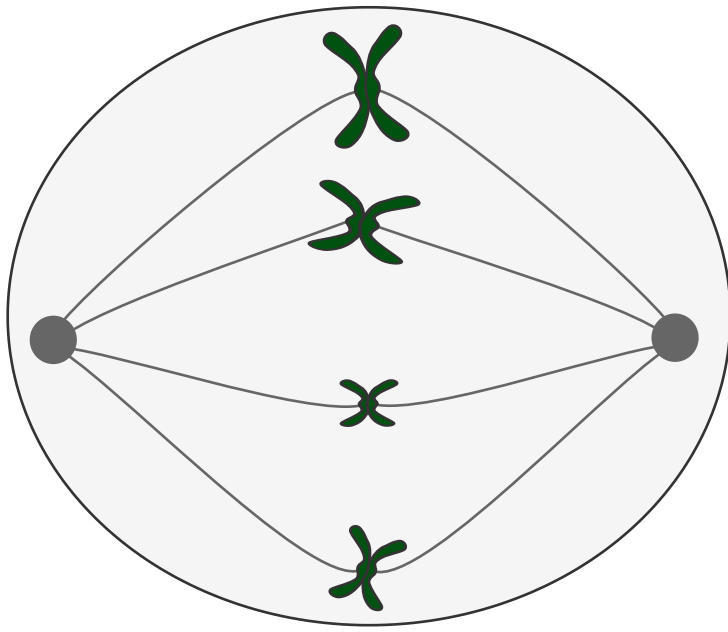
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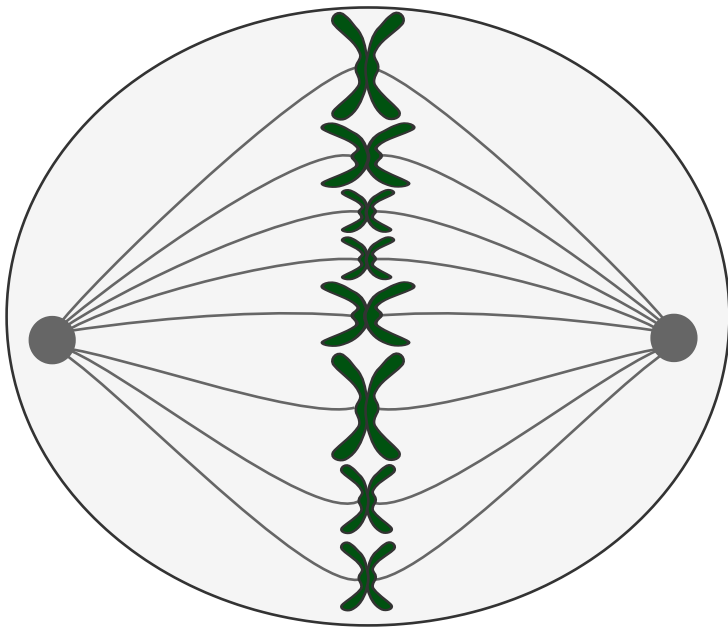
Mitosis and Meiosis

A Level
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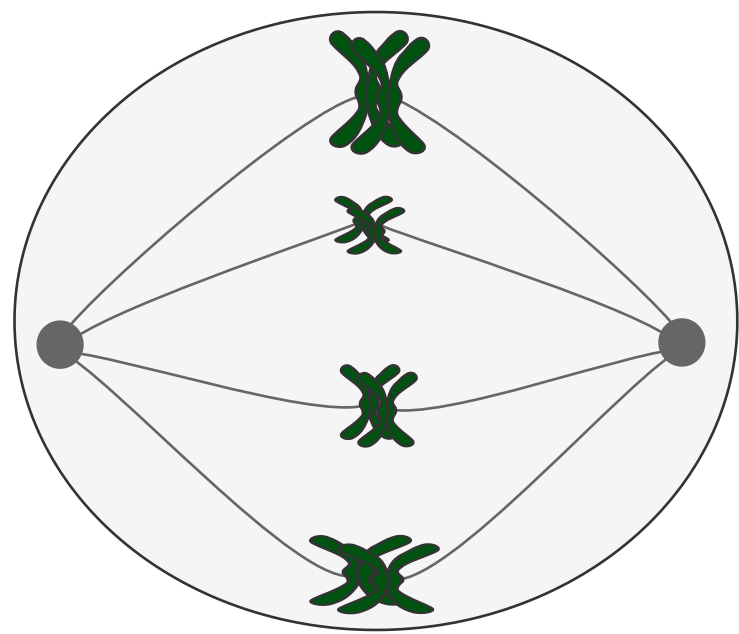
The images below show cells from the same organism undergoing different types of cell division.



A



B



C

Part A Mitosis or Meiosis?

Match the cell above to the type of cell division.

- cell A:
- cell B:
- cell C:

Items:

- mitosis
- meiosis I
- meiosis II

Part B Cell division phases

Which phase of cell division are all of these cells undergoing?

Part C Chromosome numbers

How many chromosomes would a normal sperm cell from this species have?

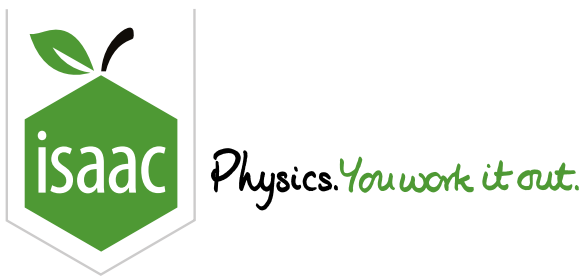
How many chromosomes would a normal zygote from this species have?

Created for isaacphysics.org by Lewis Thomson

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Zygote Cleavage

A Level



A zygote (fertilised egg cell) is spherical and has a volume of $0.12 \mu\text{m}^3$.

In the initial stages of development, the zygote undergoes several rounds of cleavage. During cleavage, cells divide by mitosis but do not grow. Assume that when cells undergo cleavage, the daughter cells are spherical and are identical to each other.

Part A Volume

After three rounds of cleavage, what will the volume of each cell be?

What is the ratio of the volume of the zygote to the volume of one of the cells after three rounds of cleavage? Express the ratio in its simplest form (e.g. 3 : 1).

Part B Diameter

What is the ratio of the diameter of the zygote to the diameter of one of the cells after three rounds of cleavage? Express the ratio in its simplest form (e.g. 3 : 1).

The volume of a sphere is given by $\frac{4}{3}\pi r^3$, where r is the radius.

Part C Chromosome number

If the zygote is a human zygote with no chromosomal abnormalities, how many chromosomes will each cell have after three rounds of cleavage?

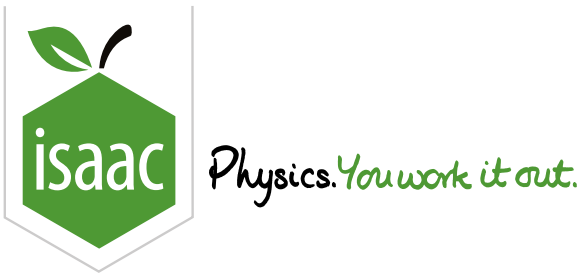
Assume that no mutations occur during cleavage.

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Moss Life Cycle

A Level
C C C

Mosses are small plants that live in damp conditions.

The life cycle of many mosses involves two multicellular stages: a gametophyte and a sporophyte.

The gametophyte contains haploid cells and produces sperm cells and egg cells.

The sporophyte contains diploid cells and produces haploid spores which can be spread easily through the air.

A spore germinates and grows into a gametophyte.

Figure 1 shows the life cycle of the moss *Funaria*.

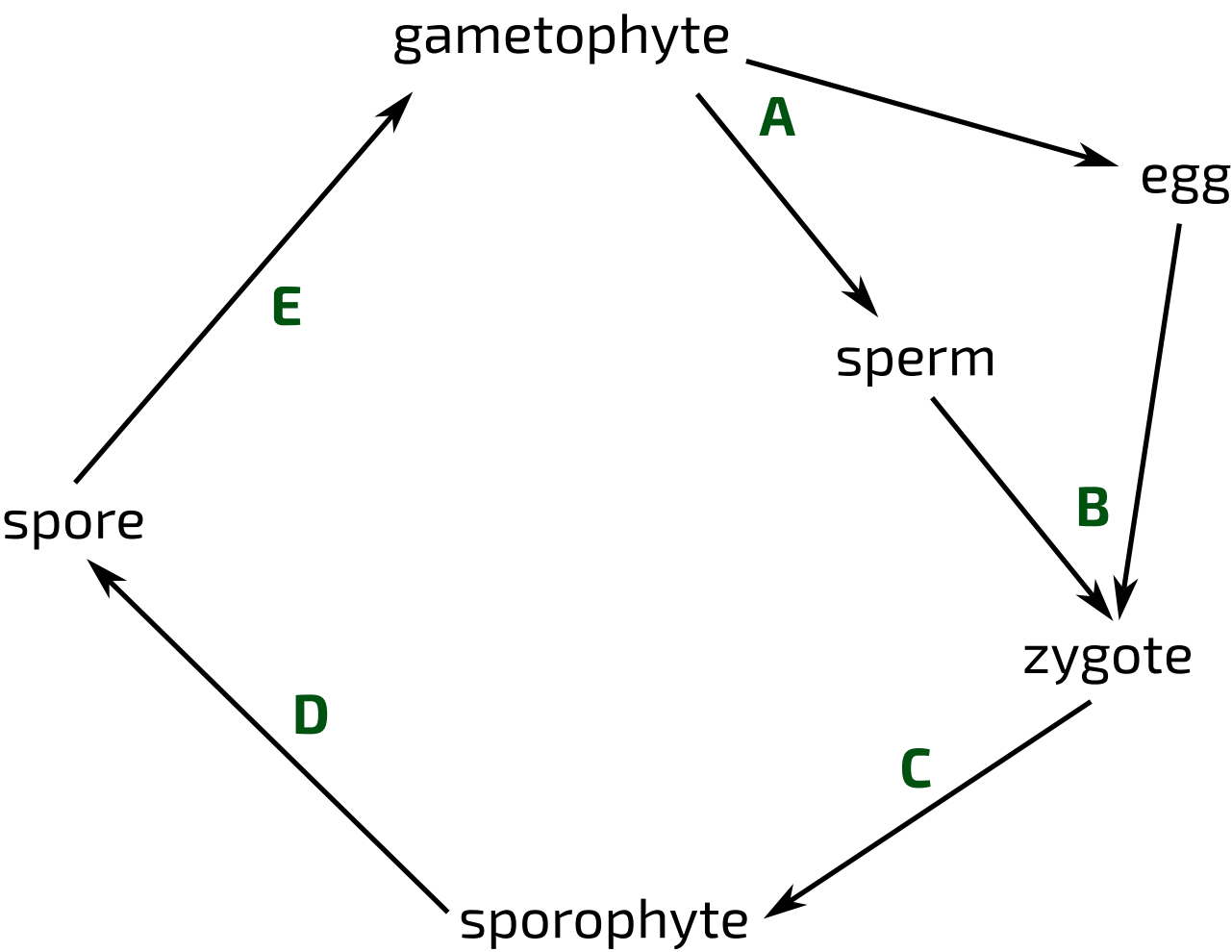


Figure 1: Life cycle of the moss *Funaria*. Letters A-E represent different cell processes.

Part A Meiosis & mitosis

Which arrow(s) in **Figure 1** represent(s) **meiosis**? Select all that apply.

- ☐ A
 - ☐ B
 - ☐ C
 - ☐ D
 - ☐ E
-

Which arrow(s) in **Figure 1** represent(s) **mitosis**? Select all that apply.

- ☐ A
 - ☐ B
 - ☐ C
 - ☐ D
 - ☐ E
-

Part B DNA strands

The haploid gametophyte of one species of *Funaria* contains 28 chromosomes per cell.

A single DNA molecule contains two strands.

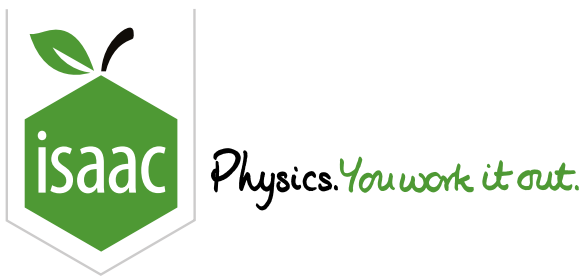
Calculate the number of strands of DNA present in the nucleus of the zygote immediately before mitosis.

Adapted with permission from OCR A Level Biology A, November 2020, Biological diversity, Question 19c

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Nutrient Solution

A Level



A scientist conducts an experiment to study a single-celled organism in a growth tube.

The organism divides once every 50 minutes using binary fission. Binary fission produces the same number of daughter cells per division as a cell dividing by mitosis.

The scientist starts with 150 cells. The experiment is left for 300 minutes.

The average volume of each cell is $5 \mu\text{m}^3$.

To ensure there are sufficient nutrients available for the cells, the final volume of cells within the tube must not be more than 1 % of the total volume of material inside the tube.

What is the minimum volume of nutrient solution required inside the growth tube at the start of the experiment?

Assume that all the cells are alive and capable of dividing.

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