ANSWER KEY.

ZornScience
zornscience.org

The Root Growth Map

Biology | ANSWER KEY

Sample answers and data. Accept answers that match the group's own data and reasoning.

Draft lab. This lab has not been tested in a classroom yet. Your teacher may change some steps, times or amounts.

The Puzzle

A root can grow a centimeter in a day. Does the whole root stretch, like a rubber band, or does the new growth come from one place? You will mark a young root with ink dots 2 mm apart, then see which spaces between the dots get longer.

Question

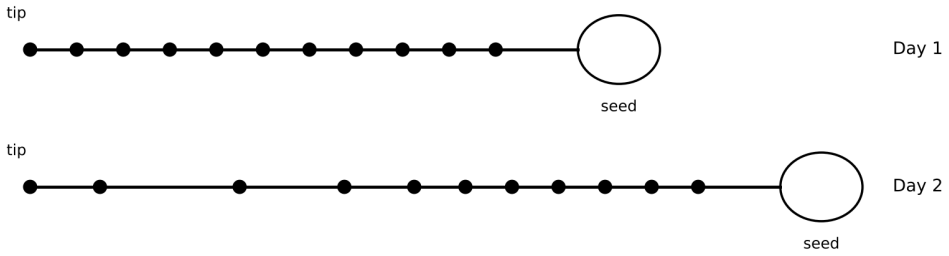
Where along a root does growth happen?

Safety

- Ink can stain. Wear gloves if your teacher provides them.
- Do not eat seeds or seedlings. Wash your hands after the lab.

Materials (per group)

- 2 bean or pea seedlings with straight roots 2 to 3 cm long
- Fine-tip permanent marker, or a thread dipped in ink
- Ruler (mm) or graph paper, hand lens
- Cup with a wet paper towel rolled inside, toothpick



Day 1: dots every 2 mm from the tip. Day 2: some spaces have stretched.

Before the Lab

1. Predict which intervals will grow the most: near the tip, in the middle, or near the seed. Explain.

Answers vary. Expected: just behind the tip, because new cells are made near the tip.

CC BY-NC-SA 4.0 | zornscience.org

Procedure

Day 1

1. Gently blot the root dry with a paper towel. Lay it on graph paper.
2. Starting at the very tip, make a tiny dot every 2 mm along the root, for 10 intervals (20 mm). Keep the dots as small as you can.
3. Slide the seedling between the wet paper towel and the cup wall, root pointing straight down, so you can see the dots.
4. Leave the cup in a dark, warm place for 24 hours. Keep the towel wet.

Day 2

1. Remove the seedling and lay it on the graph paper.
2. Measure the length of each interval between dots, starting at the tip. Use the hand lens.
3. Record your data and look for root hairs. Note which intervals have them.

Data

Table 1. Interval lengths

Interval (from tip)	Start length (mm)	Length after 24 h (mm)	Growth (mm)
1 (0 to 2 mm)	2.0	**3.0**	**1.0**
2 (2 to 4 mm)	2.0	**6.0**	**4.0**
3 (4 to 6 mm)	2.0	**4.5**	**2.5**
4 (6 to 8 mm)	2.0	**3.0**	**1.0**
5 (8 to 10 mm)	2.0	**2.2**	**0.2**
6 (10 to 12 mm)	2.0	**2.0**	**0.0**
7 (12 to 14 mm)	2.0	**2.0**	**0.0**
8 (14 to 16 mm)	2.0	**2.0**	**0.0**
9 (16 to 18 mm)	2.0	**2.0**	**0.0**
10 (18 to 20 mm)	2.0	**2.0**	**0.0**

2. Make a bar graph of growth (mm) for each interval, with the tip on the left.

Expected graph: the tallest bars are intervals 2 and 3 (about 2.5 to 4 mm of growth). Interval 1 grows a little. Intervals 6 to 10 show almost no growth (sample).

Analysis

3. How much did the root grow in total? Which intervals grew most?

8.7 mm in 24 hours (28.7 - 20.0) (sample). Intervals 2 and 3, about 2 to 6 mm from the tip, grew the most.

CC BY-NC-SA 4.0 | zornscience.org

4. Did the root stretch along its whole length? Use your data to explain.

No. Intervals 6 to 10 (more than 10 mm from the tip) did not change length. All of the growth happened within about 10 mm of the tip.

5. Near the very tip, cells divide by mitosis. Just behind that, the new cells get longer. Use this to explain why the biggest growth was a few millimeters behind the tip, not at the tip itself.

The tip region makes many new, small cells, which adds only a little length. Those cells then stretch to many times their size in the zone just behind the tip, which is where most of the lengthening happens.

6. Root hairs grow from cells that have finished growing and become specialized. Where did you see root hairs, and what does this tell you about those cells?

Farther from the tip, in the older region that did not lengthen. Those cells have stopped dividing and stretching and have differentiated into cells that absorb water.

7. Claim, evidence, reasoning: Where does a root grow, and what role does mitosis play?

Claim

A root grows only near its tip, where cells divide by mitosis and then lengthen.

Evidence

Intervals within about 10 mm of the tip grew up to 4 mm in 24 hours, while intervals farther back grew 0 mm (sample).

Reasoning

Mitosis at the tip adds new cells, which elongate just behind it. Older cells farther back have differentiated and no longer divide or stretch.

CC BY-NC-SA 4.0 | zornscience.org