ANSWER KEY.

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Same Seeds, Different Colors

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

Radish sprouts from the same packet can come up deep purple on a sunny windowsill but pale and yellow-white in a dark cupboard. The purple color is a pigment called **anthocyanin**. Every cell in every seedling has the same genes for making it. So why are some seedlings purple and others pale?

Question

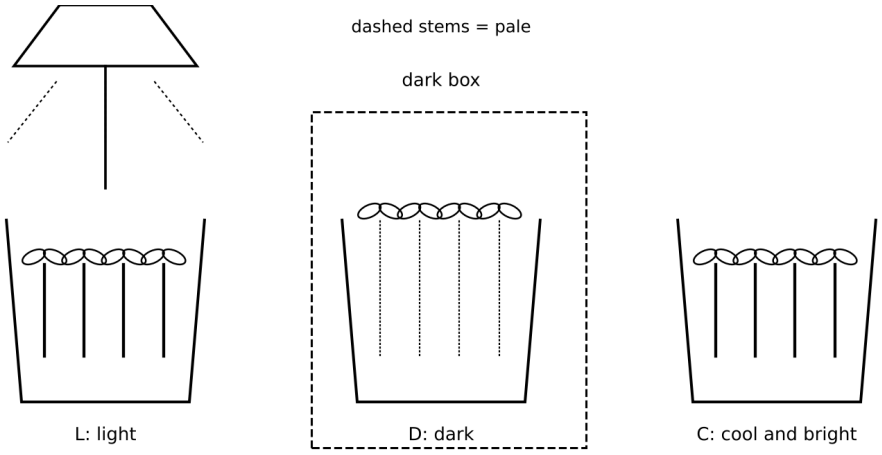
How do light and temperature affect how much anthocyanin pigment radish seedlings make?

Safety

- Wear goggles when using vinegar.
- Do not eat the seeds or sprouts. Wash your hands after the lab.

Materials (per group)

- Red radish sprouting seeds (about 1 teaspoon per cup)
- 3 clear cups with wet paper towels, labeled L (light), D (dark), C (cool and bright)
- Scissors, plastic spoon, 6 small clear vials or cups, white vinegar, dropper
- White paper for comparing colors



Three cups from the same seed packet, grown in three conditions.

Before the Lab

1. Write one question you could test about why seedlings with the same genes might look different.

Sample: Does light change how much pigment a seedling makes, even though its genes are the same?

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Procedure

Day 1

1. Sprinkle a teaspoon of seeds on the wet towel in each cup. Cover loosely with plastic wrap.
2. Put cup L under a lamp at room temperature, cup D in a dark box at room temperature, and cup C in a cool, bright place your teacher chooses (such as next to a cold window). Keep the towels wet.

Day 5

1. Observe the stem (hypocotyl) color in each cup and record it.
2. From each cup, cut 10 stems just below the leaves. Put them in a vial with 5 mL of vinegar and crush them with the spoon. Wait 10 minutes.
3. Make standards from extract L: Full (undiluted), 1/2 (1 mL extract + 1 mL vinegar), 1/4, and 1/8.
4. Hold each extract against white paper and find the closest standard. If an extract is darker than Full, mix it 1:1 with vinegar, match it again, and double the score.
5. Optional: move half of the cup D seedlings into the light. Check their color 2 days later.

Data

Table 1. Anthocyanin results

Cup	Condition	Stem color (words)	Pigment score (Full = 1)
L	Light, room temp	**pink to purple**	1
D	Dark, room temp	**pale yellow-white**	**less than 1/8**
C	Cool and bright	**deep purple**	**about 2**
D moved to light (optional)	Dark, then 2 days of light	**turning pink**	**about 1/2**

Analysis

2. Rank the three conditions from most pigment to least. What two factors affected pigment?

   Cool and bright > light > dark (sample). Light and temperature both affected how much pigment was made.

3. The dark seedlings were pale. Did they lose the genes for making anthocyanin? Use evidence to explain.

   No. They came from the same seed packet as the purple ones, and the dark seedlings moved into light turned pink within 2 days. The genes were present but not being used (expressed) in the dark.

4. Anthocyanin is made by enzymes, which are proteins. Use the words **gene**, **transcription**, and **protein** to explain how light could lead to more pigment.

   Light acts as a signal that turns on transcription of the pigment-making genes. More mRNA is made and translated into more enzyme proteins, and the enzymes make more anthocyanin.

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5. A seedling that can never make anthocyanin, even in bright light, is found in your cup. Is this more likely a difference in gene expression or a mutation? Explain.

A mutation. If it stays pale in bright light while its neighbors turn purple, the gene itself is probably changed, so it cannot make a working enzyme. Expression differences change with conditions; a mutation does not.

6. Claim, evidence, reasoning: Do organisms with the same genes always have the same traits?

Claim

No. Organisms with the same genes can show different traits because the environment changes which genes are expressed.

Evidence

Seedlings from one packet were deep purple in cool bright conditions, pink in light, and pale in the dark; dark seedlings turned pink after moving to light (sample).

Reasoning

Every cell has the same DNA, but cells only make proteins from genes that are switched on. Light and cold switch on the pigment genes, so the trait changed without the DNA changing.

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