5.9 Plant responses and phytochrome

Name: _____ Class: _____ Date: _____ **Total: 21 marks**

KEY WORDS phytochrome • auxin • gibberellin • aleurone layer

Objective

Practise statements 8.11-8.12 with Core Practical 18: phytochrome and flowering, auxin in elongation, gibberellins in germination, and investigating plant responses.

1 Key knowledge and worked examples

■ **Phytochrome - a light switch**

Two interconvertible forms: **Pr** absorbs red light (660 nm) and becomes **Pfr**; **Pfr** absorbs far-red (730 nm) and becomes Pr. Sunlight contains more red than far-red, so in daylight Pfr accumulates - the active form that triggers flowering in long-day plants and germination in light-sensitive seeds. In darkness Pfr slowly reverts.

■ **Auxin (IAA)**

Produced at shoot tips; moves down by active transport; elongates cells by pumping H+ into the wall (acid growth) so the wall loosens. Unequal distribution bends shoots toward light.

■ **Gibberellins**

From the embryo of a germinating seed; induce amylase in the aleurone layer of the endosperm; the amylase digests starch to maltose feeding the embryo. That is why gibberellin treatment raises germination percentage and speed.

■ **Worked example: designing the germination experiment**

Fifty lettuce seeds each in light, darkness, red-light flash, red flash then far-red flash. Germination: high in light, low in dark, high after red, LOW after red-then-far-red (the last flash wins - Pr has returned). The reversal is the evidence that Pfr is the active form.

2 Practice

2.1 Name the form of phytochrome that absorbs red light and the form active in daylight. [2]

2.2 State the enzyme induced by gibberellin in germinating barley, and its substrate. [2]

2.3 Explain how auxin causes a shoot to bend toward light. [3]

3 Exam-style questions

3.1 Describe an experiment to show that gibberellin increases the rate of germination, including controls, the measurements taken and the expected results. [5]

3.2 A long-day plant flowers only when nights are shorter than a critical length. Explain how phytochrome controls this response, referring to the two forms and the effect of daylight. [5]

3.3 Coleus cuttings are treated with auxin on one side of an agar block. Predict the growth of roots and shoots on the treated and untreated sides, and explain the basis of the difference. [4]

Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

2.1 Pr absorbs red; Pfr accumulates in daylight.

2.2 Amylase; starch (in the endosperm).

2.3 Auxin accumulates on the shaded side; it elongates those cells more; the shoot bends toward the light because the shaded side grows faster.

3.1 Equal batches of same-age seeds (e.g. 50 cress), one soaked in gibberellin solution, a control in distilled water; identical temperature, moisture and light; count germinated seeds daily and record the time to 50 % germination; gibberellin batch germinates faster and to a higher percentage.

3.2 Daylight converts Pr to Pfr, so Pfr accumulates during the day; in long days (short nights) Pfr remains high through the dark interval, too briefly for reversion; high Pfr triggers flowering in long-day plants; in short days the long night allows Pfr to revert to Pr, and flowering is not triggered.

3.3 Auxin at moderate concentration promotes root growth on the treated side; shoots respond similarly at low concentration; roots are far more auxin-sensitive, so concentrations that promote shoots may inhibit roots - high auxin on the root side suppresses growth there; differential growth produces bending - roots down, shoots up, in both cases toward greater growth.