3.2.2 Rates, microscopy and the root-tip squash

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

KEY WORDS graticule • stage micrometer • mitotic index

Objective

Handle the measurement practicals of Units 1–2: enzyme initial rates (CP4), the microscope and graticule (CP5), the root-tip squash and mitotic index (CP6), plant-section drawings (CP7) and fibre tensile strength (CP8). Original practice for the Unit 3 assessed skills.

1 Key knowledge and worked examples

■ Initial rate from a time course

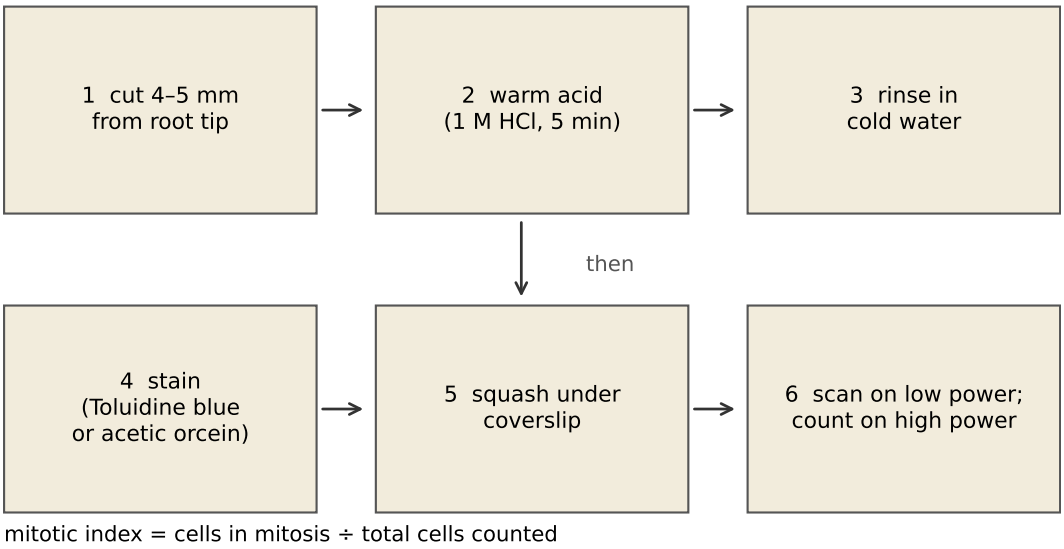
Mix enzyme and substrate at a controlled temperature and pH; sample at fixed intervals; test each sample (iodine for starch). Plot product or substrate against time and read the **initial rate** from the steep start of the curve – or use 1/time to a fixed endpoint as a rate **proxy** , valid only when the endpoint and starting concentrations are identical.

$$\text{rate proxy} = 1/t = 1/40 \text{ s}^{-1} = 0.025 \text{ s}^{-1}$$

■ The graticule converts eyepiece units to real lengths

An eyepiece **graticule** is a ruler in the eyepiece; its divisions mean different real lengths at each magnification, so calibrate it against a **stage micrometer** at the magnification you use. At ×400, if one graticule division = 2.5 µm, a cell 12 divisions long is 30 µm.

Root-tip squash, then count



Mitotic index = cells in mitosis ÷ total cells counted. Percentages of cells per stage × total cells gives counts: 80 % of 98 cells = 78.4, reported as 78 – a fraction of a cell cannot be observed.

Drawings earn marks by convention

Plan diagrams show tissues, no individual cells, no shading. Cell drawings use clean lines with straight label lines. Record magnification or a scale bar for every drawing. Fibre strength: same length and treatment of fibres, increasing masses until break, compare the mass at break.

2 Practice

2.1 State the four stages of mitosis in order, and name the stage a sample has reached if 80 % of its cells sit condensed on the equator with no separated chromatids. [3]

2.2 A graticule division is 2.5 µm at ×400. A cell spans 14 divisions. Calculate its length, and the length it would span if the same cell were viewed at ×100 where one division equals 10 µm. [3]

2.3 Of 450 cells counted in a squash, 36 are in mitosis. Calculate the mitotic index and, for a 20-hour cell cycle, the time spent in mitosis. [3]

2.4 Explain why iodine is tested on removed samples rather than added into the starch–amylase mixture. [2]

3 Exam-style questions

3.1 Describe how a root sample is prepared and examined to find the percentage of cells in each stage of mitosis, naming the stain you would use. [4]

3.2 Amylase acts on starch at 25 °C and at 60 °C. The endpoint (first negative iodine test) comes at 160 s and 20 s respectively. Calculate both rate proxies, and explain what the comparison does and does not tell you about enzyme structure. [4]

3.3 Fibres extracted from a nettle stem are mounted with masses added until each breaks: untreated fibres break at a mean of 310 g, alkali-treated at 145 g, with ranges of ±40 g and ±25 g. Describe an improvement that would tighten these comparisons, and state one conclusion the data supports and one it does not. [4]