2.6 Plant products, mineral ions and drug testing

Name: _____ Class: _____ Date: _____ **Total: 20 marks**

KEY WORDS sustainability • nitrate • zone of inhibition • double-blind • placebo

Objective

Practise statements 4.7-4.13 with Core Practicals 9: sustainability of plant products, mineral-ion roles, antimicrobials from plants, bacterial growth conditions and the logic of drug testing.

1 Key knowledge and worked examples

■ Sustainability

A material is sustainable when its supply regenerates at least as fast as its use. Plant fibres (hemp, sisal) and starch-based plastics can be sustainable: the carbon they contain came from the air recently, and the plants regrow. Oil-based plastics return fossil carbon and persist.

■ Three ions to know cold

Nitrate – nitrogen for amino acids (deficiency: stunted growth). **Calcium** – cross-links pectin in the middle lamella, wall stability, signalling (deficiency: dead growing tips). **Magnesium** – central atom of chlorophyll (deficiency: yellowing between veins).

■ Antimicrobials and drug testing

Core Practical 9: spread a bacterial lawn, place plant-extract discs (and solvent-only controls) on agar, incubate, measure **zones of inhibition**. Modern drug testing: preclinical (cells, animals) → phase 1 small healthy group (safety) → phase 2 small patient group (dose, effect) → phase 3 large blind trial vs placebo (effect, side-effects) → licensing and phase 4 monitoring. Historical failures (thalidomide) wrote these rules.

■ **Worked example: zone of inhibition**

Disc diameter 6 mm, inhibition zone diameter 16 mm. Clear zone radius $= 8 - 3 = 5$ mm. Compare zones of the same disc size only, on the same agar depth and incubation – a bigger zone means more diffusion or more sensitivity, not automatically a stronger extract.

2 Practice

2.1 Explain why a starch-based drinking cup is described as more sustainable than a plastic one. [2]

2.2 A farmer's crops show yellowing between the veins of leaves. Name the deficient ion and explain the symptom. [2]

2.3 State why a solvent-only disc is included in an antimicrobial test. [1]

3 Exam-style questions

3.1 Olive-leaf extract is tested against three bacterial species. The table gives mean inhibition-zone diameters.

Bacterium	Zone with extract / mm	Zone with solvent only / mm
A	18	0
B	9	0
C	0	0

Describe what the solvent-only column shows, compare the sensitivity of the three species, and give two conditions of the test that must be identical for a fair comparison. [5]

3.2 William Buckley's 1862 trial of willow-bark tea compared patients who received the tea with patients who received nothing, and both groups knew which they received. Describe two weaknesses of this design compared with a modern double-blind randomised trial, and name the phase of modern testing that a double-blind large-scale trial belongs to. [5]

3.3 A bioplastic is made from plant starch and another from petroleum. Compare the two for carbon source, rate of regeneration of raw material and degradability, and explain why "bioplastic" alone does not guarantee sustainability unless the crops are grown sustainably. [5]

Solutions

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

2.1 Its starch comes from plants that regrow year on year, recently fixing atmospheric carbon, and it degrades naturally instead of persisting like petroleum plastic.

2.2 Magnesium; magnesium is part of the chlorophyll molecule, so without it chlorophyll is lost and the leaf yellows between the veins where chlorophyll density is highest.

2.3 To show the solvent itself has no antibacterial effect – the zone is caused by the extract alone.

3.1 The solvent has no effect on any species, so the zones are due to the extract. A is most sensitive (largest zone), B moderately sensitive, C resistant – no inhibition at all. Identical conditions: same agar and depth, same incubation temperature and time, same bacterial lawn density, same disc size and extract concentration (any two, B1, B1).

3.2 No placebo – patients receiving nothing know it, and knowing alters reported symptoms; not blinded and not randomised – doctors' and patients' expectations bias the outcomes, and unrandomised groups may differ in severity. It belongs to phase 3.

3.3 Bioplastic carbon comes from plants that fixed atmospheric CO_2 recently and regrow – renewable; petroleum carbon is fossil, regenerating only over geological time. Bioplastic generally degrades faster than petroleum plastic. But if its crops displace food, consume irrigation and fertiliser or destroy habitat, the balance tips: sustainability depends on how the crop is grown, not on the material's name.