6 · Practical Skills in Biology II

Pearson Edexcel · International A-Level · Biology

Planning like a scientist, writing like an examiner

WBI16 is the last Biology paper you will sit, and it looks like no other: one question may hand you a half-complete statistics table, another asks you to design a whole **investigation** from a **hypothesis** you did not choose. Everything comes from the practical work of Units 4 and 5 – **respirometers** , **spirometers** , **quadrats** , dilution plates – but now you must plan, measure, present, test and conclude at IA2 depth.

WBI16/01 Practical Skills in Biology II is 1 hour 20 minutes, 50 marks, all compulsory. The specification's assessed list matches Unit 3's, with one difference in emphasis: *plan whole investigations, analyse data and evaluate results and methodology* – a 16-mark plan question closes the paper, and statistics enter: standard deviations, null hypotheses and a correlation coefficient with critical values.

The IA2 core practicals (Topics 5–8)

Core practical	Method core	What is measured
10 Photosynthesis rate	Aquatic plant under light of varied intensity/wavelength, temperature, CO_2 supply; gas collected over time	Gas volume per time; rate and limiting-factor plateaus
11 Ecology of a habitat	Quadrats and **transects** ; **abiotic** factors measured at each site	Distribution and **abundance** ; means with spread
12 Development rate	Seedling growth or brine-shrimp hatching at different temperatures, ethical use of organisms	Growth/hatch rate per temperature
13 Liquid-culture growth	Microorganism grown in broth; samples over time, safe and ethical use	Growth curve by cell count, mass or **turbidity**
14 Antibiotics on bacteria	**Aseptic** plating; antibiotic discs or plant extracts on a seeded lawn; incubate inverted below 30 °C	**Zones of inhibition**
15 Respiration in yeast	Artificial hydrogen carrier – **redox indicator** (TTC, methylene blue, DCPIP) – changes colour as yeast respires; the direction depends on the indicator	Time to colour change at each condition
16 Respirometer and RQ	Organism in a sealed chamber; CO_2 absorbent (soda lime) draws the fluid marker as O_2 is used; with and without the absorber gives RQ	O_2 uptake per time; RQ = CO_2 produced ÷ O_2 used
17 Exercise and ventilation	Spirometer trace: **tidal volume** , breathing rate, **minute ventilation** , O_2 uptake before and after exercise	Recovery time to resting values
18 Amylase in germinating grain	Extracts from grains at different germination times tested on starch	Appearance/effect of amylase with germination

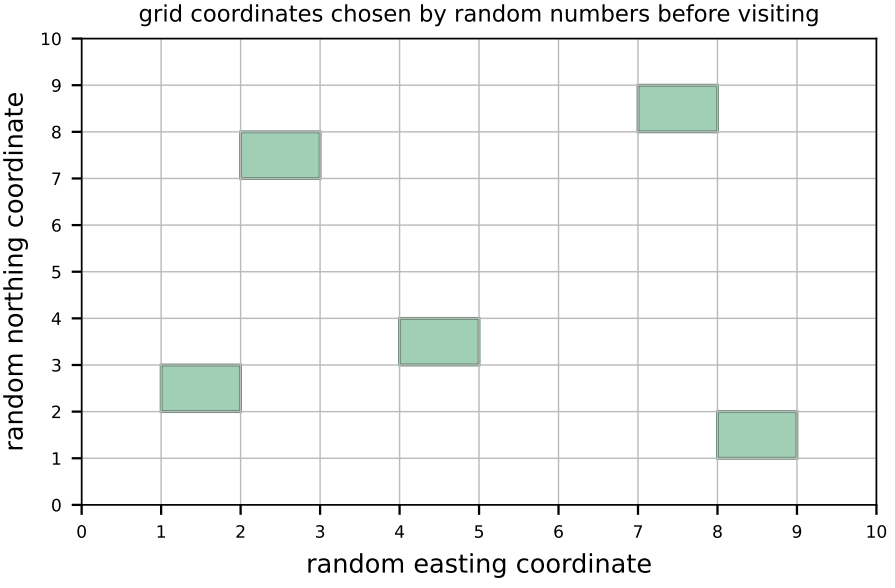
The 16-mark plan, taken apart

The closing question (2025: fitness programmes and recovery time) pays out in named blocks – answer in the same order. **Ethics** : **informed consent** of

volunteers; no one is forced to participate. **Safety**: sterilise or replace the mouthpiece between students (infection); check volunteers are healthy enough for the exercise. **Method, nine marks**: two groups (with and without the fitness programme); the **dependent variable** stated as *the time for the breathing rate and tidal volume to return to resting values*; apparatus used in detail – soda lime in the canister, nose clip, practise breaths first; find the resting values first; the same standardised exercise for everyone; two **control variables** **and** the method of control for one; repeats giving means **and standard deviations** . **Recording and analysis**: a table of raw times with headings and units from which means are calculated; a bar graph of mean recovery time per group (two groups) tested with a **t-test** t , or a line/scatter graph (several fitness levels) tested with a **correlation** test. **Limitations** : volunteers' lives outside the experiment cannot be fully controlled; apparatus difficulties (leaks, soda lime exhausted, abnormal breathing through a mouthpiece).

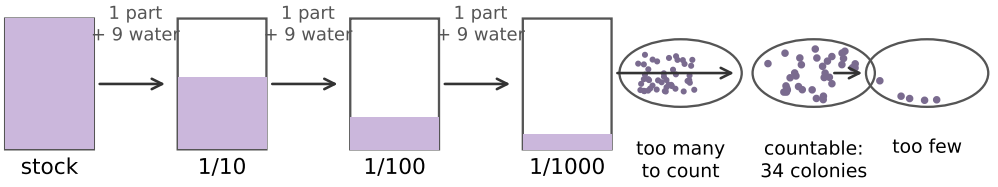
Sampling a habitat fairly

Random sampling has a method: lay a grid over the area, generate random **coordinate** pairs (random numbers, or numbers drawn from a bag), and only then visit those points with the quadrat. Saying "sample at random" earns nothing. Record the abiotic variables that matter – soil pH, moisture, minerals, light intensity, season – and control what you can by choosing matched sites. A photograph's **magnification** is image ÷ actual: an earthworm 5.0 cm in a photograph and 13.5 cm real gives ×0.37 – photographs can be smaller than life.



A sampling grid with coordinates chosen by random numbers before visiting, five quadrat squares marked.

Counting the uncountable



spread a known volume of each dilution on agar, incubate at a fixed temperature for a fixed time, count the plate with 30–300 separate colonies, then multiply back by the dilution factor

Serial dilution from stock to 1/1000: too many to count, a countable 34-colony plate, too few.

A drop of soil suspension holds too many bacteria to count, so **dilution plating** justifies each step: **serially dilute** the culture (1 part + 9 parts water, repeated) *because* raw samples are too numerous to count; plate a known volume of a suitable dilution *so that* separate **colonies** can be counted; incubate for a fixed time and temperature *so that* colonies become visible; work aseptically *to avoid* **contamination** and counting errors. Use a countable plate and the method's accepted count range. Colony count × **dilution factor** ÷ plated volume estimates colony-forming units per unit volume; one colony can come from one cell or a clump. Use approved teaching cultures and supervised school procedures.

Statistics I: standard deviation

The formula is supplied; the skill is completing the table. For five sites with masses 18.1, 19.7, 16.2, 13.8, 17.1 g (mean 16.98 ≈ 17.0): each deviation $(X - \bar{X})$ is squared – 1.21, 7.29, 0.64, 10.24, 0.01 – summed $\sum(X - \bar{X})^2 = 19.39$, divided by $n - 1 = 4$:

$$s = \sqrt{\frac{\sum(X - \bar{X})^2}{n - 1}} = \sqrt{\frac{19.39}{4}} = \sqrt{4.8475} = 2.2 \text{ g}$$

To compare two groups, plot **mean ± SD** (**error bars**): if the bars do not overlap, the difference is likely **significant** – properly, a t-test decides.

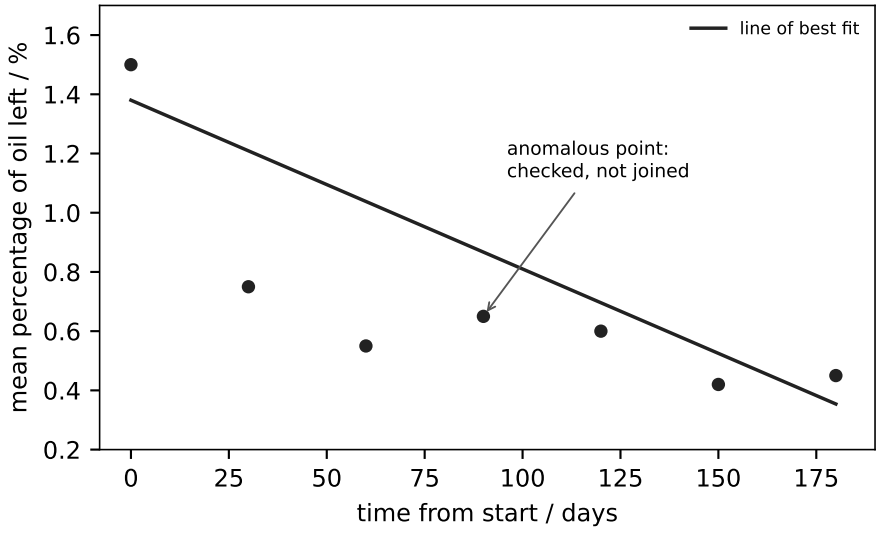
Worked example (original). Recovery times after standard exercise: trained group mean 94 s ($s = 11$, $n = 8$), untrained 126 s ($s = 14$, $n = 8$). The t-test gives $t = 32 \div \sqrt{11^2/8 + 14^2/8} = 5.08$ at $n_1 + n_2 - 2 = 14$ **degrees of freedom** ; the **critical value** at $p = 0.05$ is 2.145. Calculated exceeds critical, so reject the **null hypothesis** : the programme significantly shortens recovery. Write the same three sentences as for Spearman below – compare, reject, conclude – and quote the degrees of freedom, which examiners check.

Statistics II: Spearman's rank and the null hypothesis

Null hypothesis: "there is no correlation between the percentage of oil remaining and the time stored." Rank both variables (largest = 1), find each difference d and square it, then:

$$r_s = 1 - \frac{6\sum d^2}{n(n^2-1)} = 1 - \frac{6 \times 104}{7 \times 48} = 1 - 1.857 = -0.857$$

Compare the magnitude (0.857, ignore the sign for the comparison) with the critical value at $p = 0.05$ for $n = 7$ (0.786). Calculated exceeds critical, so **reject the null hypothesis**: there is a significant **negative correlation** between oil remaining and time. Write all three sentences – comparison, reject, conclusion.



A negative-correlation scatter with a line of best fit that ignores one anomalous point.

Choosing the test: difference between two group means → **t-test** (bar chart); association between two measured variables → **correlation** (scatter or line graph). Never a t-test on a correlation question.

Graphs that decide marks

The oil-decay graph is a **line graph** – time is **continuous** – with labelled **axes** and units (days; mean % oil left), linear **scales**, points plotted exactly, and a single best-fit line. The 90-day reading (0.65 %) sits above every neighbour: it is **anomalous**. The best fit ignores it; you check it by repeating that sampling, never delete it silently.

What written practice cannot do

As with Unit 3: a perfect written plan does not demonstrate that you performed aseptic technique, read a spirometer trace live, or handled organisms ethically in the room. Those competences are built in class while studying Units 4 and 5; this paper examines the thinking around them.

Check yourself

1. Name two artificial hydrogen carriers usable in CP15, and state what happens to their colour as yeast respires.
2. Write a null hypothesis for: "the number of bacteria in soil increases as crude oil is broken down."
3. Masses 21.4, 19.8, 18.6, 22.1, 20.6 g. Compute the sum of squared deviations and the standard deviation.
4. Ranks give $\sum d^2 = 104$ with $n = 7$. Calculate r_s and state the conclusion against the 0.05 critical value 0.786.
5. In the oil-decay table, which reading is anomalous, and what two things do you do about it?
6. State two abiotic variables (not temperature) affecting an earthworm study and one method of control.
7. A plan compares two groups' recovery times. Which graph and which test? And with five fitness levels?
8. Give the two ethical/safety points the spirometer plan must include before any practical work.
9. Justify "serially dilute the culture" and "spread on agar to make a lawn" in dilution plating.
10. An earthworm is 13.5 cm long and appears 5.4 cm in a photograph. Calculate the magnification.

Answers: 1 any two of TTC, methylene blue or DCPIP; as they accept hydrogen from respiration, methylene blue and DCPIP lose their blue colour, while TTC turns from colourless to red; 2 no correlation between bacterial number and oil broken down (correlation coefficient zero); 3 mean 20.5; squared deviations total 7.48; $s = \sqrt{7.48/4} = 1.4$ g; 4 $r_s = 1 - 624/336 = -0.857$; $0.857 > 0.786$, reject the null hypothesis: significant negative correlation; 5 the 90-day value (0.65 %): ignore

it on the best fit, check it by repeating that sampling; 6 two of soil pH, moisture, minerals, light, season; control e.g. compare only matched soil-moisture sites; 7 bar graph of means and a t-test; five levels: scatter/line graph and a correlation test; 8 informed consent (no compulsion); sterilise or replace the mouthpiece (infection); 9 dilution brings numbers down to countable; the lawn separates individuals so each forms a countable colony; 10 $5.4/13.5 = 0.40$ ($\times 0.4$).