

Skills in Biology

Skills in Biology International Edition

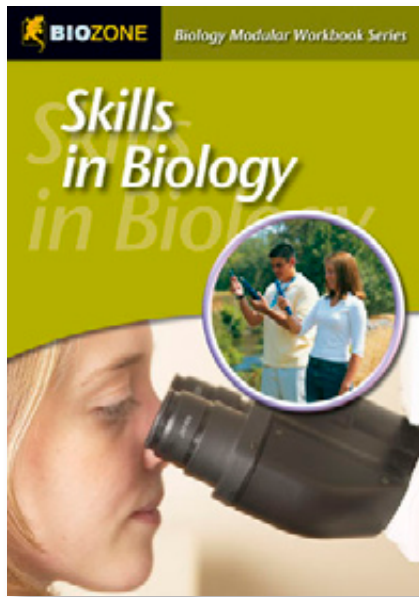
An essential supplement for all biology students, Skills in Biology provides comprehensive guidelines for planning and executing biological investigations in both the laboratory and the field.

Suitability:

- Grades 10-12
- Community College

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Biozone's unique formula encourages self direction, while dovetailing with traditional resources.



Mark and Recapture Sampling

The mark and recapture method of estimating population size is based on the ability of animal populations where individuals are highly mobile. It is not as useful where animals do not move or move very little. The number of animals caught in each sample must be large enough to be useful. The technique is outlined in the diagram below.

First capture

10 of the animals are captured and marked with a unique identifier.

Release back into the natural population

The marked animals are released back into the natural population.

Second capture

Only a number of the second capture are marked animals.

The Lincoln Index

$$\frac{\text{Total population}}{\text{Number of marked animals in the second sample}} = \frac{\text{No. of animals in 1st sample (all marked)}}{\text{Total no. of animals in 2nd sample (marked + unmarked)}}$$

The mark and recapture technique comprises a number of simple steps:

1. The population is sampled by capturing as many of the individuals as possible and marking them.
2. Each animal is marked in a way that does not harm the animal and is not likely to be rubbed off or lost.
3. Return the animals to the habitat and have them live long enough to be recaptured along with the natural population to take place.
4. Take another sample of the population (this does not need to be the same size as the first sample). Mark those that have not been previously marked.
5. Determine the number of marked + unmarked animals in the second sample. Use the equation above to estimate the size of the natural population.

Related activities: Sampling Populations, Sampling Animal Populations

Quadrat Sampling

Quadrat sampling is a method of which organisms in a certain area are counted or measured. It is used to estimate population densities when the organisms present are too numerous to count in total. It can be used to estimate population densities of plants, animals, fungi, bacteria, protists, and other organisms. Quadrats may be used without a frame when studying a uniform, well-distributed population. They can also be used to estimate the number of individuals in a certain area and to use this information to work out the abundance or percentage cover for the whole site. The number of quadrats used and their size should be appropriate to the type of organism involved to be studied.

Quadrat

10x10 grid

Grid

10x10 grid

Guidelines for Quadrat Use:

1. The area of each quadrat must be known exactly and clearly marked out on the ground. The quadrat should have to be square if it is to be used for calculating area.
2. The quadrat should be placed in a random position. This can be done by throwing a coin or a dice.
3. The quadrat should be placed in a random position. This can be done by throwing a coin or a dice.
4. The size of the quadrat should be appropriate to the organisms involved. A large site would be best.
5. The quadrat must be representative of the whole area. This is usually achieved by random sampling.

Counting a quadrat population

An estimator by the name of Lloyd (1967) sampled quadrats in Wytham Woods. Each quadrat was 30 cm x 30 cm. Lloyd counted the number of plants in each quadrat. The results are given in the table below. Use the data in the table to answer the following questions:

1. Determine the average number of centipedes captured per quadrat.
2. Calculate the estimated average density of centipedes per square meter (remember that each quadrat is 0.09 square metres in area).
3. List any of the data for individual quadrats, describe in general terms the distribution of the quadrats in the sample area.
4. Describe one factor that might account for the distribution pattern.

Related activities: Quadrat-Based Estimation, Sampling a Field Site Population

Chi-Squared Exercise in Ecology

The following exercise illustrates the use of chi-squared (χ^2) to compare observed values of habitat preferences to the expected values. In the second exercise, the results of an investigation into habitat preferences for one of the four species of snails are presented for analysis (Table 2).

1. State your null hypothesis for this investigation (H₀).

2. State the alternative hypothesis (H₁).

3. Use the chi-squared test to determine if the differences observed between the samples are significant or if they can be attributed to chance alone. The table of critical values of χ^2 is provided in 'The Chi-Squared Test' in Skills in Biology.

4. Enter the observed values in the table below. Calculate the chi-squared value using the equation:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

5. Calculate the degrees of freedom.

6. Using the χ^2 table, state the P-value corresponding to your calculated χ^2 value.

7. State whether or not you reject your null hypothesis.

8. The results of an investigation into habitat preferences in snails. In particular, they were waiting to know if the snails preferred a humid atmosphere to a dry one, so the results are given in the table below. They designed a simple investigation to test the idea. The snails were randomly placed into a choice chamber for 8 minutes where they could choose between dry and humid conditions (alternating). The investigator consisted of two trials with ten snails used in each trial. The results are shown in Table 2 (right).

9. State the null and alternative hypotheses (H₀ and H₁).

Use a separate piece of paper (or a spreadsheet) to calculate the chi-squared value and write down your answers below:

1. Calculate the χ^2 value.
2. Calculate the degrees of freedom and state the P-value corresponding to your calculated χ^2 value.
3. State whether or not you reject your null hypothesis.

Related activities: Using the Chi-Squared Test in Ecology, Using the Chi-Squared Test in Genetics, Using Chi-Squared in Genetics

Writing Your Results

The results section is arguably the most important part of any scientific report. It is where you present your findings. When properly constructed, the results section will present your findings in a way that allows your reader to understand your data and evaluate your conclusions. The results section should be written in a clear, concise, and objective manner. It should be written in a way that allows your reader to understand your data and evaluate your conclusions. The results section should be written in a clear, concise, and objective manner. It should be written in a way that allows your reader to understand your data and evaluate your conclusions.

Results

A table of 100 data points was required for the following investigation. The results are given in the table below. Use the data in the table to answer the following questions:

1. Calculate the average number of centipedes captured per quadrat.
2. Calculate the estimated average density of centipedes per square meter (remember that each quadrat is 0.09 square metres in area).
3. List any of the data for individual quadrats, describe in general terms the distribution of the quadrats in the sample area.
4. Describe one factor that might account for the distribution pattern.

Related activities: Transforming Raw Data, Tables and Graphs, The Structure of a Report

Chapters

- Biological Investigations
- Field Studies
- Classification of Organisms
- Laboratory Techniques

Features

- **Introduction to the topic:**
A concise introduction to the concepts in the activity.
- **Easy to understand diagrams:**
Highly visual, clearly annotated diagrams improve the accessibility of information.
- **Consolidation and branching out:**
Activities provide information to consolidate basic knowledge, while allowing scope for exploring. Differential instruction becomes easier and students at all levels are encouraged to be 'thinkers'.
- **Write-on format:**
Activities provide information to consolidate basic knowledge, while allowing scope for exploring.
- **Tear-out pages:**
Each page has a perforation to allow easy removal for marking, or placement in a ring binder.
- **Activity Code:**
Each activity is coded to identify the skills required for its completion.

Content Overview

BIOLOGICAL INVESTIGATIONS

- Terms and Notation
- The Scientific Method
- A Guide to Research Projects
- Choosing Your Topic
- Hypotheses and Predictions
- Planning an Investigation
- Designing Your Experiment
- Recording Results
- Tables and Graphs
- Transforming Raw Data
- Types of Graphs
- Drawing Bar Graphs
- Drawing Histograms
- Drawing Pie Graphs
- Drawing Kite Graphs
- Drawing Scatter Plots
- Drawing Line Graphs
- Interpreting Line Graphs
- Taking the Next Step
- Descriptive Statistics
- The Reliability of the Mean
- Linear Regression
- Non-linear Regression
- The Student's *t* Test
- Student's *t* Test Exercise
- Comparing More Than Two Groups
- Analysis of Variance
- Using the Chi-Squared Test in Ecology
- Chi-squared Exercise in Ecology
- Using the Chi-Squared Test in Genetics
- Chi-Squared Exercise in Genetics
- The Structure of a Report
- Writing the Methods
- Writing Your Results
- Writing Your Discussion
- Report Checklist
- Citing and Listing References

FIELD STUDIES

- Sampling Populations
- Designing Your Field Study
- Monitoring Physical Factors
- Quadrat Sampling
- Quadrat-Based Estimates
- Sampling a Leaf Litter Population
- Transect Sampling
- Sampling Animal Populations
- Mark and Recapture Sampling
- Indirect Sampling
- Sampling Using Radio-Tracking

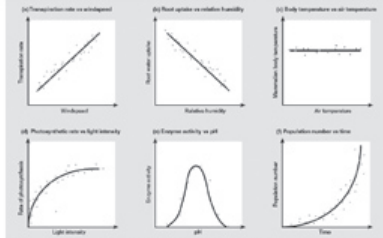
CLASSIFICATION OF ORGANISMS

- The New Tree of Life
- New Classification Schemes
- Features of Taxonomic Groups
- Classification System
- Classification Keys
- Keying Out Plant Species
- Features of the Five Kingdoms
- The Classification of Life
- Features of Animal Taxa
- Features of Fungi and Plants

LABORATORY TECHNIQUES

- Biological Drawings
- Optical Microscopes
- Electron Microscopes
- Interpreting Electron Micrographs
- Identifying Cell Structures
- Biochemical Tests
- Differential Centrifugation
- Gel Electrophoresis
- Analyzing a DNA Sample
- Techniques in Microbial Culture
- Strain Isolation
- Serial Dilution
- Plant Tissue Culture

Interpreting Line Graphs



1. For each of the graphs (1-6) above, give a description of the slope and an interpretation of how one variable changes with respect to the other. For the purpose of your description, call the independent variable (horizontal or x-axis), in each example 'variable X' and the dependent variable (vertical or y-axis) 'variable Y'. Be aware that the existence of a relationship between two variables does not necessarily mean that the relationship is causative (although it may be).

(a) Slope: Positive linear relationship, with consistently rising slope
 Interpretation: Variable Y (Concentration) increases regularly with increase in variable X (Substrate)

(b) Slope: _____
 Interpretation: _____

(c) Slope: _____
 Interpretation: _____

(d) Slope: _____
 Interpretation: _____

(e) Slope: _____
 Interpretation: _____

(f) Slope: _____
 Interpretation: _____

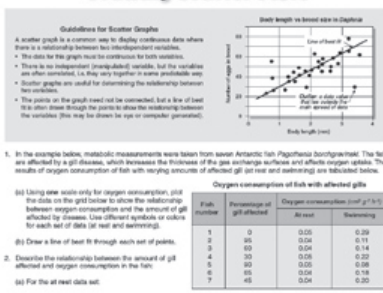
2. Study the line graph of trout, perch and shag numbers on the previous page:

(a) Describe the evidence suggesting that the shag population is exercising some control over perch numbers: _____

(b) Describe evidence that the fluctuations in shag numbers are related to fluctuations in trout numbers: _____

Related activities: Drawing Line Graphs, Linear Regression, Non-Linear Regression

Drawing Scatter Plots



Guidelines for Scatter Graphs

A scatter graph is a common way to display continuous data where there is a relationship between two independent variables.

- The data for the graph must be continuous for both variables.
- There is no independent (unrelated) variable, but the variables are often correlated. i.e. they vary together in some predictable way.
- Scatter graphs are useful for examining the relationship between two variables.
- The points on the graph need not be connected, but a line of best fit often shows through the points to show the relationship between the variables (this may be done by eye or computer generated).

1. In the example below, metabolic measurements were taken from several Antarctic fish *Pagetopsis birchgroveri*. The fish are affected by a gill disease, which increases the thickness of the gill exchange surface and affects oxygen uptake. The results of oxygen consumption of fish with varying amounts of affected gill are read and summarised are indicated below.

Oxygen consumption of fish with affected gills

Fish number	Percentage of gill affected	Oxygen consumption ($\text{ml g}^{-1} \text{h}^{-1}$)	Swimming
1	0	0.20	0.20
2	20	0.24	0.11
3	40	0.24	0.14
4	30	0.28	0.22
5	60	0.28	0.26
6	20	0.24	0.18
7	40	0.24	0.20

(a) Using one axis only for oxygen consumption, plot the data on the grid below to show the relationship between oxygen concentration and the amount of gill affected by disease. Use different symbols or colors for each set of data (at rest and swimming).

(b) Draw a line of best fit through each set of points.

(c) Describe the relationship between the amount of gill affected and oxygen consumption in the fish.

(d) For the at rest data set: _____

(e) For the swimming data set: _____

2. Describe how the gill disease affects oxygen uptake in resting fish: _____

Related activities: Types of Graphs, Interpreting Line Graphs, Linear Regression

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