

BIOLOGY 144 - BIODIVERSITY AND ECOLOGY

(16 credits: 3L, 3P)

MODULE FRAMEWORK AND STUDY GUIDE

FOR 2022

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1. Welcome

Welcome to Biology 144 (Biodiversity and Ecology). This module focuses on the biodiversity and ecology of biological life. It consists of four rather different submodules: the diversity of micro-organisms, plants and animals, as well as ecological principals and global change.

1.1 Lectures

In 2022, this module will be offered on campus with no simultaneous live streaming.

We offer Face-to-face lectures (real-time) with the lecturers in the class venues (attendance is strongly recommended).

In this module, we follow Option 1 of the Language Policy of the University of Stellenbosch. This means that you will be able to receive lectures, practicals/tutorials in English or Afrikaans (separate classes).

1.2 Weekly work

Check each week's "What should I do this week?" on SUNLearn. These sections will explain what you are required to do each week, including assessments, tutorials, other due dates and important information. Please make sure that you understand what you need to do and if you are unsure about anything, email Mrs Nel at acnel@sun.ac.za. Please use your SU email address to simplify communication.

2. This Study Guide

This Study Guide contains important information about the course content, your tests, tutorials and practicals, administrative matters, and who you can contact if you experience problems or have queries. Please make sure that you know and understand the content.

The information in this document is complete and correct (as far as possible). However, we sometimes have to make changes or add content. Any changes and any additional information will be announced on SUNLearn. **It is your responsibility to make sure that you regularly check the announcements and important dates on the Calendar in SUNLearn. You may not plead ignorance if announcements have been placed.** If you are in doubt about anything in this document, you are welcome to contact Mrs Carrin Nel, Administrative Official, Room 1093, Natural Sciences Building, acnel@sun.ac.za. Please use your SU email address for all communication.

3. The aim and scope of this module

In this module, you will be introduced to the unbelievable diversity of living organisms that share the Earth with us, as well as how these organisms interact with each other and their physical environments. At the end of the module you should have a good understanding of the following:

- The system according to which all living organisms are classified, as well as the diversity of microorganisms, plants, and animals.
- The evolutionary history and development of plants and animals.
- The ecology of populations and communities, the dynamics of ecosystems, the biosphere and the future of the biosphere.

This module serves as a basis for later programmes in the biological sciences and the agricultural sciences.

4. The outcomes of this module

We designed this module so that you may gain basic knowledge and understanding of the classification and diversity of all living organisms, as well as the interaction of organisms with each other, and their environment. See the module outline for more detail about the outcomes of each submodule. During online activities or f2f practicals, several of these groups of organisms will be studied. **Completion of ALL assessments / practicals / activities / tutorials is COMPULSORY to achieve the outcomes of this module.**

5. How we assess in this module

This module follows the **flexible assessment model**. Each of the four sub-modules carries a weight of 25% of the final mark. There will be four theory tests – each with a weighting of 20% of the final mark. All **sickness tests** will be in the form of an online **oral examination**. The compulsory **practical component**, in the form of tutorials / activities / quizzes / assignments, carries a total weighting of 20% (5% per sub-module). **You need to complete ALL assessments to pass this module. Take note of the following subminimum required:**

- You need to obtain a **40% subminimum** in at least two of the four theory tests to pass the module
- AND a **40% subminimum** for the **practical component**.

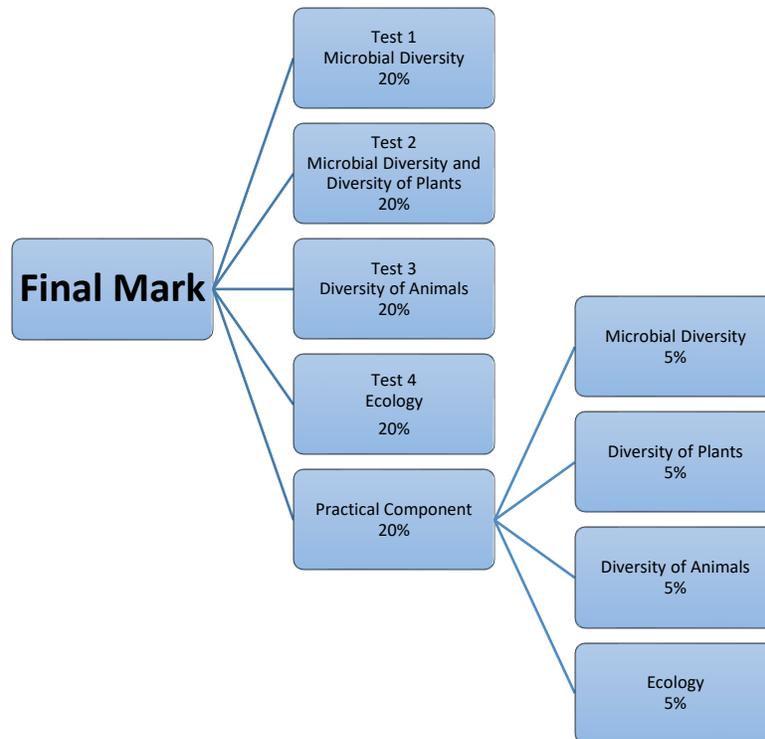


FIGURE 1: FINAL MARK CALCULATION

You pass the module if:

- Your final mark is 50% or higher, AND
- You achieved a subminimum of 40% in at least two of your theory tests, AND
- You achieved a 40% subminimum for the practical component.

Test dates:

- Test 1: Submodule 1 – Microbial Diversity: 08 Augustus 2022; 17:30
- Test 2: Submodule 1 & 2 - Microbial Diversity and Plant Diversity: 14 September 2022; 17:30
- Test 3: Submodule 3 - Animal Diversity: 12 November 2022; 14:00
- Test 4: Submodule 4 - Ecology: 29 November 2022; 09:00

No previous test or exam papers are available to anyone. No part of any assessment or test may be copied in any form.

6. The organisation and administration of this module

6.1 Prescribed textbook

Russell, Hertz, McMillan. Biology: The Dynamic Science (5th edition). Brooks/Cole Publishers. International Edition.

6.2. Module Coordinator, Sub-module Conveners and Administrative Officials

- Send all your module related queries to Mrs C Nel, the Administrative Official, acnel@sun.ac.za. More serious matters may be brought to the attention of Dr M Mouton, the Module Coordinator (marnel@sun.ac.za).
- Your sub-module related queries or questions should be asked on the Discussion Forum on SUNLearn. The appropriate lecturer or sub-module convener will answer your question on that platform.

6.3. Biology 144 sub-modules

The Biology 144 module is presented during the second semester and consists of four sub-modules as indicated in

Table 1: Biology 144 sub-modules

| Sub-module | | Number of Lectures | Department | Conveners |
|------------|----------------------|--------------------|--|---------------------------------------|
| 1 | Microbial Diversity | 10 | Microbiology 021 808 5847 Block A, JC Smuts Building | Prof M Viljoen-Bloom mv4@sun.ac.za |
| 2 | Diversity of Plants | 9 | Botany and Zoology 021 808 3236 Natural Science Building | Prof LL Dreyer ld@sun.ac.za |
| 3 | Diversity of Animals | 9 | | Prof C Simon csimon@sun.ac.za |
| 4 | Ecology | 9 | | Prof A Pauw apauw@sun.ac.za |

Table 2: Biology 144 Group Divisions for Lectures

| Group | Periods | Lecture Hall |
|---------------------------------|---|---------------------------------------|
| Group 1 English Lectures | Mon – 08:00 Wed - 09:00 Thu - 12:00 | A201 JC Smuts Building |
| Group 2.1 Afrikaans Lectures | Mon – 11:00 Wed - 10:00 Fri - 08:00 | Hall 3005 Natural Science Building |
| Group 2.2 English Lectures | Mon – 11:00 Wed - 10:00 Fri - 08:00 | A203 JC Smuts Building |

6.3. Availability of lecturers

Academic questions on learning content should be raised during the f2f classes or on the Discussion Forum on SUNLearn. Lecturers will check this forum regularly and answer your question. For other queries and problems, you can contact Mrs Nel (acnel@sun.ac.za). All communication on the administration of assessments and due dates should be addressed to Mrs Nel.

6.4. Implementation of SU's Language Policy in this Module

In this module, we follow Option 1 of the Language Policy of the University of Stellenbosch. This means that you will be able to receive lectures, practicals/tutorials in English or Afrikaans (separate classes).

7. Practicals / Tutorials

We will communicate the dates and format of all practicals on SUNLearn. **All practicals and tutorials (quizzes) are compulsory! You can therefore not pass the module without completing these assessments.** Failure to complete / hand in practical assignments will result in an incomplete mark and you will have to repeat the module in 2023. This is an important rule and applies to all three Biology-modules! If you are **absent due to unforeseen circumstances** (e.g. illness), you must send a scanned copy of a verifying document (e.g. a valid medical certificate) within seven calendar days of the date of absence to the administrative Official (Mrs Carrin Nel, acnel@sun.ac.za). The General Regulations of the University will apply. Doubtful cases will be referred to the Registrar's Office for a decision. (See SU Calendar: General 22, Part 1, p. 31).

Table 3: Practical Schedule

| WEEK | DATES | SUB-MODULE |
|-------------|---------------------|---------------------------|
| 1. | 19 / 21 July | NO PRACTICALS / TUTORIALS |
| 2. | 26 / 28 July | Microbial Diversity |
| 3. | 02 / 04 August | Microbial Diversity |
| 4. | 09 / 11 August | NO PRACTICALS / TUTORIALS |
| 5. | 16 / 18 August | Diversity of Plants |
| 6. | 23 / 25 August | Diversity of Plants |
| 7. | 30 August / 01 Sept | Diversity of Plants |
| | RECESS | |
| 8. | 13 / 15 Sep | Diversity of animals |
| 9. | 20 / 22 Sep | Diversity of Animals |
| 10. | 27 / 29 Sept | Ecology |
| 11. | 04 / 06 Oct | Ecology |
| 12. | 11 / 13 Oct | NO PRACTICALS / TUTORIALS |
| 13. | 18 / 20 Oct | NO PRACTICALS / TUTORIALS |

8. Lecture Content and Schedule

The weekly lecture content should be used in combination with the textbook to provide a complete picture of the topics in the module.

Table 4: Module Lecture Schedule

| WEEK | LECTURE | DATE AND TIME | SUBMODULE |
|--------|---------|---|----------------------|
| 1 | 1 | Mon 18 Jul (08:00 and 11:00) | Introductory Lecture |
| | 2 | Wed 20 Jul (09:00 and 10:00) | Microbial Diversity |
| | 3 | Thurs 21 Jul (12:00) & Fri 22 Jul (08:00) | Microbial Diversity |
| 2 | 4 | Mon 25 Jul (08:00 and 11:00) | Microbial Diversity |
| | 5 | Wed 27 Jul (09:00 and 10:00) | Microbial Diversity |
| | 6 | Thurs 28 Jul (12:00) & Fri 29 Jul (08:00) | Microbial Diversity |
| 3 | 7 | Mon 01 Aug (08:00 and 11:00) | Microbial Diversity |
| | 8 | Wo 03 Aug (09:00 and 10:00) | Microbial Diversity |
| | 9 | Thurs 04 Aug 12:00) & Fri 05 Aug (08:00) | Microbial Diversity |
| 4 | 10 | Mon 08 Aug (08:00 and 11:00) | Microbial Diversity |
| | 11 | Wed 10 Aug (09:00 and 10:00) | Microbial Diversity |
| | 12 | Thurs 11 Aug 12:00) & Fri 12 Aug (08:00) | Diversity of Plants |
| 5 | 13 | Mon 15 Aug (08:00 and 11:00) | Diversity of Plants |
| | 13 | Wed 17 Aug (09:00 and 10:00) | Diversity of Plants |
| | 14 | Thurs 18 Aug 12:00) & Fri 19 Aug (08:00) | Diversity of Plants |
| 6 | 15 | Mon 22 Aug (08:00 and 11:00) | Diversity of Plants |
| | 16 | Wed 24 Aug (09:00 and 10:00) | Diversity of Plants |
| | 17 | Thurs 25 Aug 12:00) and Fri 26 Aug (08:00) | Diversity of Plants |
| 7 | 18 | Mon 29 Aug (08:00 and 11:00) | Diversity of Plants |
| | 19 | Wed 31 Aug (09:00 and 10:00) | Diversity of Plants |
| | 20 | Thurs 01 Sept 12:00 & Fri 02 Sep (08:00) | Diversity of Animals |
| Recess | | | |
| 8 | 21 | Mon 12 Sept (08:00 and 11:00) | Diversity of Animals |
| | 22 | Wed 14 Sept (09:00 and 10:00) | Diversity of Animals |
| | 23 | Thurs 15 Sept 12:00 & Fri 16 Sept (08:00) | Diversity of Animals |
| 9 | 24 | Mon 19 Sep (08:00 and 11:00) | Diversity of Animals |
| | 25 | Wed 21 Sep (09:00 and 10:00) | Diversity of Animals |
| | 26 | Thurs 22 Sept 12:00 and Fri 23 Sept (08:00) | Diversity of Animals |
| 10 | 27 | Mon 26 Sep (08:00 and 11:00) | Diversity of Animals |
| | 28 | Wed 28 Sept (09:00 and 10:00) | Diversity of Animals |
| | 29 | Thurs 29 Sept (12:00) & Fri 30 Sept (08:00) | Ecology |
| 11 | 30 | Mom 03 Oct (08:00 and 11:00) | Ecology |
| | 31 | Wed 05 Oct (09:00 and 10:00) | Ecology |
| | 32 | Thurs 06 Oct (12:00) & Fri 07 Oct (08:00) | Ecology |
| 12 | 33 | Mon 10 Oct (08:00 and 11:00) | Ecology |
| | 34 | Wed 12 Oct (09:00 and 10:00) | Ecology |
| | 35 | Thurs 13 Oct (12:00) & Fri 14 Oct (08:00) | Ecology |
| 13 | 36 | Mon 17 Oct (08:00 and 11:00) | Ecology |
| | 37 | Wed 19 Oct (09:00 and 10:00) | Ecology |
| | 38 | Thurs 20 Oct (12:00) & Fri 21 Oct (08:00) | NO LECTURES |

9. Module Outline and Study Objectives for Biology 144 in 2022

9.1 Microbial Diversity

| | |
|---------------------------|--|
| Lecture 1 | INTRODUCTION TO MICROBIOLOGY: Characteristics, importance and classification; microscopy |
| Lecture 2 | VIRUSES: Characteristics, morphology, classification, reproduction, bacteriophages, HIV, emerging viruses (Chapter 17) |
| Lecture 3 & 4 | MICROBIAL GROWTH: Microbial growth curves, environmental factors, nutrient requirements |
| Lecture 5 & 6 | BACTERIA: Morphology, growth and reproduction, diversity & classification, metabolism, environmental importance, horizontal gene transfer (Chapter 26) |
| Lecture 7 | FUNGI: Morphology, classification, reproduction, metabolism, and environmental importance (Chapter 30) |
| Lecture 8 | YEASTS: Morphology, reproduction, metabolism, alcohol production, model for eukaryotic genetics, examples of yeasts (Chapter 30) |
| Lecture 9 & 10 | MICROBES IN ACTION: Genetic Engineering, Medical Microbiology, Industrial Microbiology, and Environmental Microbiology |

Practical 1 - Isolating, handling & storage of microbes

Practical 2 – Microbial diversity and growth

Microbial Diversity: Study objectives

1. Understand the importance of microbial organisms.
2. Understand the classification of microbial organisms.
3. Be able to identify the most important differences between Eukaryotes, Eubacteria & Archaea.
4. Morphology and replication of viruses
5. Be able to name a few diseases caused by viruses
6. Be able to discuss the replication of bacteriophages (lysogenic *versus* lytic cycle)
7. Discuss HIV as example of a retrovirus, and understand important differences with coronaviruses
8. Understand how microbes were first discovered and isolated
9. Understand Koch's postulates to prove a direct microbe-disease relationship.

10. Be able to discuss the various environmental factors that can influence microbial growth.
11. Know the groupings of microbial organisms based on their environmental growth requirements (e.g. phototrophs, acidophiles, anaerobes and halophiles)
12. Understand how microbes grow, and how we observe and measure their growth
13. Know the types of growth media and how we prepare them
14. Understand the characteristics of the growth phases of a culture in a batch system
15. Be able to discuss different methods for the control of microbial organisms
16. Know the general morphology of bacterial cells and the function of different cellular components
17. Know the different bacterial cell shapes and groupings (also refer to Practical lectures)
18. Recognise the different nutritional requirements of bacteria (autotrophy, heterotrophy, phototrophy, chemotrophy)
19. Discuss the environmental importance of bacteria
20. Understand the different forms of gene transfer
21. Know the most important aspects regarding the morphology and reproduction of fungi
22. Know the five main taxonomic groups and their most important characteristics
23. Discuss the reproductive cycle of the Basidiomycetes
24. Understand the environmental importance of fungi
25. Discuss the basic morphology of *S. cerevisiae*, *S. pombe* and *C. albicans*
26. Discuss the reproductive cycle of *Saccharomyces cerevisiae*
27. Discuss metabolism in *Saccharomyces cerevisiae* and its importance in alcoholic fermentations
28. Understand the principles of genetic engineering and some of its applications
29. Name a few medical applications of microbial organisms
30. Name a few industrial applications of microbial organisms
31. Understand the role of microbes in environmental management

Microbial Diversity practicals: Study objectives

1. Understand sterilization techniques and “aseptic technique”.
2. Electron Microscopes as well as their applications
3. Know the use of the streak-, spread- and pour-plate techniques.
4. Know the methods used to count microbial cells (living and/or dead).
5. Understand the basic differences between yeast, fungi and bacteria when viewed under a microscope (cell morphology) and when seen on agar in a Petri dish (colony morphology)

9.2 Diversity of Plants

Lecture 1 – Phylogeny and the tree of life, interpreting phylogenies

Lecture 2 – Protist biology, algal diversity – Euglenozoa, Rhodophyta

Lecture 3 – Algal diversity – Chlorophyta, ecological importance of algae

Lecture 4 – Embryophytes, adaptation to life on land

Lecture 5 – Non-vascular plants, bryophyte diversity, moss life cycle

Lecture 6 – Seedless vascular plant diversity – ferns, whisk ferns, horsetails and clubmosses

Lecture 7 – Seed plants – Gymnosperm diversity, evolution of seed

Lecture 8 – Gymnosperm diversity –conifers, cycads, *Ginkgo*, gnetophytes

Lecture 9 – Angiosperm diversity, flowers and fruit

Practical 1 - Diversity and evolutionary relations within the Archaeplastid Algae / Diversity and evolutionary relations within the bryophytes

Practical 2 - Diversity and evolutionary relations within the seedless vascular plants

Practical 3 - Diversity and evolutionary relations within seed plant

Diversity of plants: Study objectives

Upon completion of this sub-module you should be able to:

1. Discuss plant-like and non-plant-like characters of the red and green algae.
2. Discuss the relationship between green plants and the green algae.
3. Understand and discuss the division of the plant kingdom into 11 phyla.
4. Discuss the adaptation of plants to a life on land.
5. Have a good overview of the plant life cycle, and be able to explain how the plant life cycle differs from that of animals and fungi respectively.
6. To explain what is meant by the following: gametophyte generation, sporophyte generation, haploid, diploid, spore, gamete, mitosis, meiosis.
7. To understand what distinguishes the three bryophyte divisions from the 8 vascular plant divisions.
8. Discuss the diversity of the bryophytes.
9. Have a good overview of the general morphology, sexual reproduction and diversity of the phyla

Bryophyta, Hepatophyta and Anthocerothyta.

10. Discuss the ecological importance of the bryophytes.
11. Discuss the diversity of vascular plants.
12. Have a good overview of the general morphology, sexual reproduction and diversity of the phyla Pterophyta, Lycophyta and Equisetophyta.
13. Discuss the economic importance of the seedless vascular plants.
14. Discuss the diversity among the seed plants.
15. Distinguish between the gymnosperms and angiosperms.
16. Explain the following terms: androecium, antheridium, archegonium, gynoecium, heterosporous, homosporous.
17. Have a good overview of the general morphology, sexual reproduction and diversity of the phyla Coniferophyta, Cycadophyta, Gnetophyta and Ginkgophyta.
18. Write an essay on the life cycle of *Pinus*.
19. Understand the origins and distinguishing characters of the angiosperms.
20. Distinguish between monocots and eudicots.
21. Write an essay on the life cycle of the angiosperms.
22. Define and discuss the following terms: pollen grain, stamen, anther, filament, pollination, carpel, ovary, pistil, stigma, integument, micropyle, nucellus, double fertilization, endosperm, seed, testa.
23. Discuss the main evolutionary trends and adaptations in the plant lineage.

9.3 Diversity of animals

- | | |
|------------------|--|
| Lecture 1 | Introduction to Animal diversity: What is an animal? Key innovations in animal evolution, animal phylogeny and classification (Chapter 31.1 to 31.3) |
| Lecture 2 | Parazoa; Radiata (Cnidaria); Lophotrochozoan protostomes (Platyhelminthes) (Chapter 31.4 to 31.6) |
| Lecture 3 | Lophotrochozoan protostomes (Mollusca; Annelida) (Chapter 31.6) |
| Lecture 4 | Ecdysozoan protostomes (Nematoda; Onychophora; Arthropoda) (Chapter 31.7) |
| Lecture 5 | Invertebrate Deuterostomes (Echinodermata; Hemichordata; Chordata (overview & invertebrate subphyla)) (Chapter 32.1 to 32.2) |
| Lecture 6 | Chordata: Origin and diversification of vertebrates (the 'fishes') (Chapter 32.3 to 32.5) |

- Lecture 7** Chordata: The evolution of tetrapods (Amphibia) and evolution of terrestrial tetrapods (Amniota) (Chapter 32.6 to 32.8)
- Lecture 8** Chordata: Living Archelosaurs (birds and crocodilians) and Mammalia (Monotremes; Marsupials) (Chapter 32.9 to 32.10)
- Lecture 9** Chordata: Mammalia (Placentals; Non-human primates; evolution of humans) (Chapter 32.11 to 32.12)

Diversity of animals: Study objectives

1. The characteristics that distinguish animals from other clades in Eukarya
2. The link between motility, heterotrophy, the evolution of elaborate nervous and sensory systems, and how these are linked to the evolution of animals
3. Patterns of body symmetry and the presence or absence of a body cavity of major animal lineages
4. The phylogenetic tree for animals based on molecular sequence data in terms of the distribution of morphological characters in different animal groups
5. Characteristics that define the phyla classified as Lophotrochozoa and Ecdysozoa, respectively
6. The morphological adaptations to a parasitic lifestyle, using Platyhelminthes as a case study
7. The characteristics of arthropods that were critical for their success in terrestrial habitats
8. The morphological characteristics shared among members of the Echinodermata
9. The distinguishing characteristics of chordates and vertebrates, and how these differ from other animal phyla
10. Jaws of vertebrates evolved from supporting structures in the pharynx of invertebrate chordates
11. The defining characteristics of 'fish' classified as Chondrichthyes and Osteichthyes
12. The evidence that supports the hypothesis that Tetrapoda evolved from certain species of Sarcopterygii
13. The special adaptations and pre-adaptations that contributed to success of Amniotia in terrestrial environments
14. The reasons why early tetrapods emerged from water
15. The defining characteristics of Synapsida and Reptilia

16. The special adaptations that allow birds to fly and how these differ from, or are the same as, their closest non-flying relatives and adaptations to flight in mammals
17. The distinguishing characteristics of Primates and human skeleton.

Practical 1 Understanding complexity of animal form: body symmetry, tissue layers, and body cavities and parasitism: Cnidaria, Platyhelminthes, Nematoda & Annelida

Practical 2 Peer assessment of self-guided Animal identification practical

9.4 Ecology

Lecture 1: Introduction and concepts – Definitions; climate

Lecture 2: Terrestrial biomes of the World

Lecture 3: South African Biomes (Lecture notes)

Lecture 4: South African Biomes (Lecture notes)

Lecture 5: Population Ecology- Population growth and life history continued

Lecture 6: Community Ecology- Communities and interactions and niches

Lecture 7: Community Ecology- Communities and interactions and niches continued

Lecture 8: Ecosystems and Nutrients: energy flow, chemical cycles, and trophic levels

Lecture 9: Ecosystems and Nutrients: energy flow, chemical cycles, trophic levels continued

Practical 1 & 2 – Botanical Garden Practical 1 & 2.

Ecology: Study objectives

Following your study of this sub-module you should be able to:

1. Get a broad overview of ecology.
2. Describe the properties of populations.
3. Understand important aspects of population dynamics.
4. Understand how we can assess populations that are changing.
5. Understand how species interactions shape communities.
6. Understand the concepts of the niche (fundamental vs realised) and habitat.
7. Know about the classic experiments by Connell (rocky shore ecology) and Gause (*Paramecium*)
8. Understand the principles of resource partitioning and competitive exclusion

9. Describe how to detect competition.
10. Understand the different ways in which species in communities can interact with one another, and how these interactions can have important evolutionary outcomes.
11. Understand interactions among ecological processes.
12. Be familiar with biogeochemical cycles and understand the consequences of their disruption.
13. Understand trophic levels within food chains and how species at different trophic levels may interact. Understand basic global patterns of diversity and relate the variety of hypotheses used to explain these patterns.
14. Understand how and why climate shapes the character of ecosystems.
15. Describe key features of the major global biomes (terrestrial) and aquatic ecosystems
16. Describe key features of the primary South African biome.