

## Biology

Biology is a scientific subject that has its origins in the need of human beings to know more about themselves and the world around them. It is the theory of life, its origins, evolution, forms and conditions. Biological contexts are often complex and studied at various levels, from the individual molecule to global ecosystems.

### Aim of the subject

Teaching in the subject of biology should aim at helping students develop knowledge of biological concepts, theories, models and working methods. It should contribute to students developing their understanding of the importance of biology in society, such as quality of life and health through medicine, and for the protection of the Earth's ecosystems through ecology. Teaching should give students the opportunity to develop a scientific perspective of the surrounding world based on the theory of evolution. Teaching should take advantage of current research and students' experiences, curiosity and creativity. Teaching should also help students participate in public debates and discuss ethical issues and views from a scientific perspective.

Molecular biology, as well as many other areas of biology, is developing at a rapid pace. Development occurs in interaction between theory and experiment, where hypotheses, theories and models are tested, re-assessed and revised. Teaching should thus cover the development, limitations and areas of applicability of theories and models. It should contribute to students developing the ability to work theoretically and experimentally, and to communicate using scientific language. Teaching should also help students develop the ability to critically assess and distinguish between statements based on scientific and non-scientific foundations.

Teaching should cover scientific working methods, such as formulating and searching for answers, making systematic observations, planning and carrying out experiments and field studies, as well as processing, interpreting and critically assessing results and information. Teaching should give students the opportunity to discuss and present analyses and conclusions. They should also be given the opportunity to use computerised equipment for collecting, simulating, calculating, processing and presenting data.

### Teaching in the subject of biology should give students the opportunities to develop the following:

- 1) Knowledge of the concepts, models, theories and working methods of biology, and also an understanding of their development.
- 2) The ability to analyse and find answers to subject-related questions, and to identify, formulate and solve problems. The ability to reflect on and assess chosen strategies, methods and results.
- 3) The ability to plan, carry out, interpret and report field studies, experiments and observations, and also the ability to handle materials and equipment.

- 4) Knowledge of the importance of biology for the individual and society.
- 5) The ability to use knowledge of biology to communicate, and also to examine and use information.

### **Courses in the subject**

Biology 1, 100 credits, which builds on knowledge from the compulsory school or equivalent.

Biology 2, 100 credits, which builds on the course biology 1.

Biotechnology, 100 credits, which builds on the course biology 1.

# Biology 1

The course biology 1 covers points 1–5 under the heading Aim of the subject.

## Core content

Teaching in the course should cover the following core content:

### Ecology

- Structure and dynamics of ecosystems. Energy flows and recycling materials, and also ecosystem services.
- Natural and man-made disturbances in the ecosystem linked to questions about bearing capacity and biological diversity.
- Population size, variety and composition of species, and factors affecting this.
- Ecologically sustainable development, locally and globally, and different ways of contributing to this.

### Genetics

- Properties and functions of eukaryotes and prokaryotes.
- The structure of gene pools and the laws and mechanisms of heredity. Cell division, DNA replication and mutation.
- Gene expression. Protein synthesis, monogenic and polygenic characteristics, heredity and environment.
- Genetic applications. Opportunities, risks and ethical issues.

### Evolution

- Scientific theories about the origins and development of life.
- Evolutionary mechanisms, such as natural selection and sexual selection and their importance in speciation.
- Behaviour of organisms and the importance of behaviour for survival and reproductive success.
- Taxonomic systems and principles for classifying organisms. Main groups of organisms and evolutionary history.
- Development of biology with emphasis on evolution.

### The nature of biology and its working methods

- The characteristics of a scientific problem.
- Models and theories as simplifications of reality. How they change over time.

- The importance of experimental work in testing, re-assessing and revising hypotheses, theories and models.
- Identifying and studying problems and issues using reasoning from biology.
- Planning and carrying out field studies, experiments and observations, and the formulation and testing of hypotheses related to this.
- Assessing results and conclusions by analysing choice of methods, work processes and sources of error.
- Field studies and research in ecology, including the use of modern equipment. Simulation of evolutionary mechanisms e.g. natural selection. How organisms are identified. Microscopy in studying cells or cell division.
- Processing of biological data using simple statistical methods.
- Use of genetic data for the study of biological contexts.
- Views on societal issues based on biological explanatory models e.g. issues concerning sustainable development.

## Knowledge requirements

### Grade E

Students give an account **in basic terms** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with some certainty** to find answers to questions, and also to describe and **illustrate** biological relationships at different levels, from molecular level to ecosystem level. Based on **some** examples, students give an account **in basic terms** of how the models and theories of biology are developed. Students also evaluate the validity of the models and theories and their limitations in **simple** assessments.

Students analyse and look for answers to **simple** questions in **familiar situations** with **satisfactory** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses and formulate **with some certainty** their own issues. Students plan and carry out **in consultation** with the supervisor experiments and field studies in a satisfactory way. In addition, students handle materials and equipment safely. Furthermore, students interpret their results, evaluate their methods in **simple** assessments and give the reasons for their conclusions with **simple** reasoning.

Students discuss **in basic terms** issues concerning the importance of biology for the individual and society. In their discussions, students put forward **simple** arguments and give an account **in basic terms** of the consequences of **some** possible viewpoints.

Students use **with some certainty** the language of science and adapt **to some extent** their communication to purpose and context. In addition, students use different types of sources and make **simple** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### **Grade D**

Grade D means that the knowledge requirements for grade E and most of C are satisfied.

### **Grade C**

Students give an account **in detail** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with some certainty** to find answers to questions, and also to describe and **illustrate** biological relationships at different levels, from molecular level to ecosystem level. Based on **some** examples, students give an account **in basic terms** of how the models and theories of biology are developed. Students also evaluate the validity of the models and theories and their limitations in **simple** assessments.

Students analyse and look for answers to **complex** issues in **familiar situations** with **satisfactory** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses, and formulate **with some certainty** their own issues. Students plan and carry out **after consultation** with the supervisor experiments and field studies in a satisfactory way. In addition, students handle materials and equipment safely. Furthermore, students interpret their results, assess their methods in **simple** assessments and give the reasons for their conclusions with **well grounded** reasoning.

Students discuss **in detail** issues concerning the importance of biology for the individual and society. In their discussions, students put forward **well grounded** arguments, and give an account **in detail** of the consequences of **some** possible viewpoints.

Students use **with some certainty** the language of science and adapt **to a great extent** their communication to purpose and context. In addition, students use different types of sources and make **well grounded** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### **Grade B**

Grade B means that the knowledge requirements for grade C and most of A are satisfied.

### **Grade A**

Students give an account **in detail and in a balanced way** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with certainty** to look for answers to issues, and to **describe and generalise** biological relationships at different levels, from the level of molecules to that of ecosystems. Based on **some examples** students give an account **in detail and a balanced way** of how the theories and models of biology are developed. Students also assess the validity and limitations of models and theories in **balanced** assessments.

Students analyse and look for answers to **complex** questions in **familiar and new situations** with **good** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses and formulate **with certainty complex** issues. Students plan and carry out **after consultation** with the supervisor experiments and field studies in a satisfactory way. In addition, students handle materials and equipment safely. Furthermore, students interpret their results, assess their methods in **balanced** assessments and give reasons for their conclusions with **well grounded and balanced** reasoning. **Where necessary, students also propose changes.**

Students discuss **in detail and in a balanced way complex** issues concerning the importance of biology for the individual and society. In their discussions, students put forward **well grounded and balanced** arguments and give an account **in detail and in a balanced way** of the consequences of **several** possible viewpoints. **Students also propose new issues for discussion.**

Students use **with some certainty** the language of science and adapt **to a great extent** their communication to purpose and context. Students use different types of sources and make **well grounded and balanced** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with certainty** their own ability and the requirements of the situation.

## **Biology 2**

The course biology 2, covers points 1–5 under the heading Aim of the subject.

### **Core content**

Teaching in the course should cover the following core content:

#### **Cell and molecular biology**

- Cell life cycles and differentiation, development from egg to adult. Cell communication.
- Functions of cell division. Life processes and their regulation e.g. photosynthesis, metabolism and transport over membranes. Evolutionary perspectives on molecular biology.
- Application areas of cell and molecular biology. Opportunities, risks and ethical issues.

#### **Functions of the organism**

- Physiology of human beings and other animals. The organ system and its structure, function and interaction. Regulation of the organism through the hormone system and the nervous system.
- Relationships between evolution and the functional structure and living processes of organisms.
- The immune system, infection paths and infections. The structure, functions and reproduction of viruses.
- Microorganisms and their importance for health and ill-health. Antibiotics and processes related to evolution.
- Relationships between living conditions, health and ill-health. Ethics of medical issues.
- What happens in the body during menstruation, love, sex and pregnancy. How sexually transmittable diseases and unwanted pregnancies can be prevented.
- Life cycles and physiology of plants and funguses.
- Use of modern equipment for physiological studies and laboratory experiments.

#### **The nature of biology and its working methods**

- Models and theories as representations of reality. Areas where models and theories can be applied, and also how they can be developed, generalised or replaced by other models and theories over time.
- Identifying and studying problems and issues using reasoning from biology.
- The importance of experimental work in testing, re-assessing and revising hypotheses, theories and models.

- Planning and carrying out field studies, experiments and observations, and the formulation and testing of hypotheses related to this. Assessing results and conclusions by analysing choice of methods, work processes and sources of error.
- Physiological studies and experiments also covering the use of modern equipment. Simple methods of molecular biology. Sterilisation and cultivation of bacteria.
- Use of genetic data for the study of biological contexts.
- Issues concerning religion, ethics and sustainable development linked to different working approaches of biology and its areas.

## Knowledge requirements

### Grade E

Students give an account **in basic terms** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with some certainty** to find answers to questions, and also to describe and **illustrate** biological relationships at different levels, from molecular level to ecosystem level. Based on **some** example, students give an account **in basic terms** of how the models and theories of biology are developed. Students also evaluate the validity of the models and theories and their limitations in **simple** assessments.

Students analyse and look for answers to **simple** questions in **familiar situations** with **satisfactory** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses and formulate **with some certainty** their own issues. Students plan and carry out **in consultation** with the supervisor experiments and field studies in a satisfactory way. In addition, students handle materials and equipment safely. Furthermore, students interpret their results, evaluate their methods in **simple** assessments and give the reasons for their conclusions with **simple** reasoning.

Students discuss **in basic terms** issues concerning the importance of biology for the individual and society. In their discussions, students put forward **simple** arguments and give an account **in basic terms** of the consequences of **some** possible viewpoints.

Students use **with some certainty** the language of science and adapt **to some extent** their communication to purpose and context. In addition, students use different types of sources and make **simple** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### Grade D

Grade D means that the knowledge requirements for grade E and most of C are satisfied.

## Grade C

Students give an account **in detail** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with some certainty** to find answers to questions, and also to describe and **illustrate** biological relationships at different levels, from molecular level to ecosystem level. Based on **some examples**, students give an account **in basic terms** of how the models and theories of biology are developed. Students also evaluate the validity of the models and theories and their limitations in **simple** assessments.

Students analyse and look for answers to **complex** issues in **familiar situations** with **satisfactory** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses, and formulate **with some certainty** their own issues. Students plan and carry out **after consultation** with the supervisor experiments and field studies in a satisfactory way. In addition, students handle materials and equipment safely. Furthermore, students interpret their results, assess their methods in **simple** assessments and give the reasons for their conclusions with **well grounded** reasoning.

Students discuss **in detail** issues concerning the importance of biology for the individual and society. In their discussions, students put forward **well grounded** arguments, and give an account **in detail** of the consequences of **some** possible viewpoints.

Students use **with some certainty** the language of science and adapt **to a great extent** their communication to purpose and context. In addition, students use different types of sources and make **well grounded** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

## Grade B

Grade B means that the knowledge requirements for grade C and most of A are satisfied.

## Grade A

Students give an account **in detail and in a balanced way** of the meaning of concepts, models, theories and working methods from each of the course's different areas. Students use these **with certainty** to look for answers to issues, and to **describe and generalise** biological relationships at different levels, from the level of molecules to that of ecosystems. Based on **some examples** students give an account **in detail and a balanced way** of how the theories and models of biology are developed. Students also assess the validity and limitations of models and theories in **balanced** assessments.

Students analyse and look for answers to **complex** questions in **familiar and new situations** with **good** results. This applies to both theoretical and practical work. In their work, students formulate relevant hypotheses and formulate **with certainty complex** issues. Students plan and carry out **after consultation** with the supervisor experiments and field studies in a satisfactory way. In addition, students handle materials and equipment safely. Furthermore, students interpret their results, assess their methods in **balanced** assessments and give reasons for their conclusions with **well grounded and balanced** reasoning. **Where necessary, students also propose changes.**

Students discuss **in detail and in a balanced way complex** issues concerning the importance of biology for the individual and society. In their discussions, students put forward **well grounded and balanced** arguments and give an account **in detail and in a balanced way** of the consequences of **several** possible viewpoints. **Students also propose new issues for discussion.**

Students use **with some certainty** the language of science and adapt **to a great extent** their communication to purpose and context. Students use different types of sources and make **well grounded and balanced** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with certainty** their own ability and the requirements of the situation.

## Biotechnology

The course biotechnology, covers points 1–5 under the heading Aim of the subject.

### Core content

*Teaching in the course should cover the following core content:*

- Experimental work in biotechnology including genetic engineering. Techniques for sterilisation, cultivation and fermentation.
- Biologically effective macromolecules, their functions and interaction within and between cells.
- User cells in industry, agriculture, medicine and research. Bacteria, yeast cells, cancer cells, stem cells and their importance in the development of biotechnology.
- Biotechnology including the tools and methods of genetics, and their use in industry, agriculture, medicine and research. Biotechnology and genetics in issues concerning ecologically sustainable development.
- Opportunities and risks of biotechnology and genetically modified organisms from ethical and societal perspectives.

### Knowledge requirements

#### Grade E

Students use **with some certainty** concepts, models, theories and working methods to look for answers to questions, and also to describe and **exemplify** phenomena in biotechnology. Based on **some** example, students give an account **in basic terms** of how biotechnology has developed.

Students analyse and look for answers with **satisfactory** results. This applies to both theoretical and practical work. Students plan and carry out **in consultation** with the supervisor investigatory work in a satisfactory way. In addition, students handle materials and equipment safely. Furthermore, students interpret their results, evaluate their methods in **simple** assessments and give the reasons for their conclusions with **simple** reasoning.

Students discuss **in basic terms** issues concerning the importance of biotechnology for the individual and society. In their discussions, students put forward **simple** arguments and give an account **in basic terms** of the consequences of **some** possible viewpoints.

Students use **with some certainty** biotechnical terms and adapt **to some** extent their communication to purpose and context. In addition, students use different types of sources and make **simple** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### Grade D

Grade D means that the knowledge requirements for grade E and most of C are satisfied.

### Grade C

Students use **with some certainty** concepts, models, theories and working methods to look for answers to questions, and also to describe and **exemplify** phenomena in biotechnology. Based on **some** examples, students give an account **in detail** of how the models and theories of biotechnology have developed.

Students analyse and look for answers to **complex** issue with **satisfactory** results. This applies to both theoretical and practical work. **In their work, students formulate with some certainty their own issues which takes the process forward.** Students plan and carry out **after consultation** with the supervisor investigatory work in a satisfactory way. In addition, students handle materials and equipment safely. Furthermore, students interpret their results, assess their methods in **simple** assessments and give the reasons for their conclusions with **well grounded** reasoning.

Students discuss **in detail** issues concerning the importance of biotechnology for the individual and society. In their discussions, students put forward **well grounded** arguments, and give an account **in detail** of the consequences of **some** possible viewpoints.

Students use **with some certainty** biotechnical terms and adapt to **a great** extent their communication to purpose and context. In addition, students use different types of sources and make **well grounded** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with some certainty** their own ability and the requirements of the situation.

### Grade B

Grade B means that the knowledge requirements for grade C and most of A are satisfied.

### Grade A

Students use **with certainty** concepts, models, theories and working methods to look for answers to questions, and also to describe and **generalise about** phenomena in biotechnology. Based on **some** examples, students give an account **in detail and in a balanced way** of how biotechnology has developed.

Students analyse and look for answers to **complex** questions with **good** results. This applies to both theoretical and practical work. **In their work, students formulate with certainty their own questions which take the process forward and deepen their reasoning.** Students plan and carry out **after consultation** with the supervisor investigatory work in a satisfactory way. In addition, students handle materials and equipment safely. Furthermore, students interpret their

results, assess their methods in **balanced** assessments and give reasons for their conclusions with **well grounded and balanced** reasoning. **Where necessary, students also propose changes.**

Students discuss **in detail and in a balanced way complex** issues concerning the importance of biotechnology for the individual and society. In discussions, students put forward **well grounded and balanced** arguments and give an account **in detail and in a balanced way** of the consequences of **several** possible viewpoints. **Students also propose new issues for discussion.**

Students use **with certainty** biotechnical terms and adapt to **a great** extent their communication to purpose and context. Students use different types of sources and make **well grounded and balanced** assessments of the credibility and relevance of their sources and information.

In consultation with the supervisor, students assess **with certainty** their own ability and the requirements of the situation.