IB WORLD SCHOOL 1309 (ZSO13 Gdańsk)

Biology

syllabus & course of study

(based on Biology guide, first exams 2016)

A. COURSE AIMS:

Biology is the study of life. An interest in life is natural for humans; not only are we living organisms ourselves, but we depend on many species for our survival and co-exist with many more. Biologists attempt to understand the living world at all levels using many different approaches and techniques. At one end of the scale is the cell, its molecular construction and complex metabolic reactions. At the other end of the scale biologists investigate the interactions that make whole ecosystems function. At the school level we aim to cultivate both theoretical and practical skills so that they complement one another naturally, as they do in a wider scientific community.

B. COURSE OBJECTIVES:

Through studying biology students should become aware of how scientists work and communicate with each other. While the scientific method may take on a wide variety of forms, it is the emphasis on a practical approach through experimental work that characterizes this subject. The aims enable students, through the overarching theme of the Nature of science, to:

1. appreciate scientific study and creativity within a global context through stimulating and challenging opportunities

2. acquire a body of knowledge, methods and techniques that characterize science and technology

3. apply and use a body of knowledge, methods and techniques that characterize science and technology

4. develop an ability to analyse, evaluate and synthesize scientific information

5. develop a critical awareness of the need for, and the value of, effective collaboration and communication during scientific activities

6. develop experimental and investigative scientific skills including the use of current technologies

7. develop and apply 21st century communication skills in the study of science

8. become critically aware, as global citizens, of the ethical implications of using science and technology

9. develop an appreciation of the possibilities and limitations of science and technology

10. develop an understanding of the relationships between scientific disciplines and their influence on other areas of knowledge.

C. COURSE OVERVIEW:

C.1. Course Content:

Core SL & HL

1. Cell biology

2. Molecular biology

3. Genetics

4. Ecology

5. Evolution and biodiversity

6. Human physiology

Additional higher level (AHL)

7. Nucleic acids

8. Metabolism, cell respiration and photosynthesis

9. Plant biology

10. Genetics and evolution

11. Animal physiology

Option (one selected)

A. Neurobiology and behavior

B. Biotechnology and bioinformatics

C. Ecology and conservation (selected for SL course)

D. Human physiology (selected for HL course)

C.2. Other requirements

Practical scheme of work · Practical activities prescribed labs included (assessed in the exam Paper 3) , 20 hours (SL); 40 hours (HL) · Individual investigation (internal assessment – IA), 10 hours (SL & HL) · Group 4 project, 10 hours (SL & HL)

C.3.Textbook& reference books

Minka Peeters Weem with Christopher Talbot, Antony Mayrhofer 4th edition, "Biology" for use with the I.B. Diploma Programme, IBID Press

D. COURSE OF STUDY

THEMES/ UNITS	**Content- topics and guiding questions**		Time provision
Cell biology - CORE	Introduction to cells.	There is a difference between the living and non-living environment. How are we able to know the difference?	15 hours
	Ultrastructures of cells	The world that we inhabit is limited by the world that we see. Is there any distinction to be drawn between knowledge claims dependent upon observations made by sense perception and knowledge claims dependent upon observations assisted by technology?	
	Membrane structure	The explanation of the structure of the plasma membrane has changed over the years as new evidence and ways of analysis have come to light. Under what circumstances is it important to learn about theories that were later discredited?	
	Membrane transport		
	The origin of cells	Biology is the study of life, yet life is an emergent property. Under what circumstances is a system approach productive in biology and under what circumstances is a reductionist approach more appropriate? How do scientists decide between competing approaches?	
	Cell division	A number of scientific discoveries are claimed to be incidental or serendipitous. To what extent might some of these scientific discoveries	

		be the result of intuition rather than luck?	
Molecular biology	Molecules to metabolism		21 hours
	Water	Claims about the "memory of water" have been categorized as pseudoscientific. What are the criteria that can be used to distinguish scientific claims from pseudoscientific claims?	
	Carbohydrates and lipids	There are conflicting views as to the harms and benefits of fats in diets. How do we decide between competing views?	
	Proteins		
	Enzymes	Development of some techniques benefits particular human populations more than others. For example, the development of lactose-free milk available in Europe and North America would have greater benefit in Africa/Asia where lactose intolerance is more prevalent. The development pf techniques requires financial investment. Should knowledge be shared when techniques developed in one part of the world are more applicable in another?	
	Structure of DNA and RNA	The story of elucidation of the structure of DNA illustrates that cooperation and collaboration among scientists exist alongside competition between research groups. To what extent is research in secret 'anti-scientific'? What is the relationship between shared and personal knowledge in the natural science?	
	DNA replication, transcription and translation		
	Cell respiration		
	Photosynthesis		
Genetics	Genes	There is link between sickle cell anemia and prevalence of malaria. How can we know whether there is casual link in such cases or imply a correlation?	15 hours

	Chromosomes		
	Meiosis	In 1922 the number of chromosomes counted in human cell was 48. This remained the establishment for 30 years, even though a review of photographic evidence from the time clearly showed that there were 46. For what reasons do existing beliefs carry a certain inertia?	
	Inheritance		
	Genetic modification and biotechnology	The use of DNA for securing convictions in legal cases is well established, yet even universally accepted theories are overturned in the light of new evidence in science. What criteria are necessary for assessing the reliability of evidence?	
Ecology - CORE	Species, communities, and ecosystems		12 hours
	Energy flow		
	Carbon cycling		
	Climate change	The precautionary principle is meant to guide decision-making in conditions where a lack of certainty exist. Is certainty ever possible in the natural sciences?	
Evolution and biodiversity - CORE	Evidence for evolution	Evolutionary history is an especially challenging area of science because experiments cannot be performed to establish past events or their causes. There are nonetheless scientific methods of establishing beyond reasonable doubt what happened in some case. How do these methods compare to those used by historians to reconstruct the past?	12 hours
	Natural selection	Natural selection is a theory. How much evidence is required to support a theory and what sort of counter evidence is require to refute it?	
	Classification of biodiversity	The adoption of system of binomial nomenclature is largely due to Swedish botanist and physician Carolus Linneaus (1707 – 1778). Linneaus also defined four groups of humans, and the divisions were based on both physical and social traits. By 21st-century standards, his descriptions can be regarded as racist. How does the social context of	

		scientific work affect the methods and findings of research? Is it necessary to consider the social context when evaluating ethical aspects of knowledge claims?	
	Cladistics	A major step forward in the study of bacteria was the recognition in 1977 by Carl Woese that Archea have a separate line of evolutionary descent from bacteria. Famous scientists, including Luria and Mayr, objected this division of the procaryotes. To what extent is conservatism in science desirable?	
Human physiology - CORE	Digestion and absorption		20 hours
	The blood system	Our currant understanding is that emotions are the product of activity in the brain rather than the heart. Is knowledge based on science more valid than knowledge based on intuition?	
	Defence against infectious disease		
	Gas exchange		
	Neurons and synapses		
	Hormones, homeostasis and reproduction		
Nucleic acids – Additional higher level (AHL)	The structure of DNA is ideally suited to its function	Highly repetitive sequences were once classified as “junk DNA” showing a degree of confidence that it had no role. To what extent do the labels and categories used in the pursuit of knowledge affect the knowledge we obtain?	9 hours
	Transcription and gene expression	The nature versus nurture debate concerning the relative importance of an individual’s innate qualities versus those acquired through experiences is still under discussion. Is it important for science to attempt to answer this question?	
	Translation		
Metabolism, cell respiration and photosynthesis - Additional higher level (AHL)	Metabolism	Many metabolic pathways have been described following a series of carefully controlled and repeated experiments. To what degree can looing at component parts give us knowledge of the whole?	14 hours

	Cell respiration	Peter Mitchell's chemiosmotic theory encountered year of opposition before it was finally accepted. For what reasons does falsification not always result in an immediate acceptance of new theories or a paradigm shift?	
	Photosynthesis	The lollipop experiment used to work out the biochemical details of the Calvin cycle shows considerable creativity. To what extent is the creation of an elegant protocol similar to the creation of work of art?	
Plant Biology - Additional higher level (AHL)	Transport in the xylem of plants		
	Transport in the phloem of plants		
	Growth in Plants	Plants communicate chemically both internally and externally. To what extent can plants be said to have language?	
	Reproduction in plants		
Genetics and evolution - Additional higher level (AHL)	Meiosis		8 hours
	Inheritance	The law of independent assortment was soon found to have exceptions when looking at linked genes. What is the difference between a law and a theory in science?	
	Gene pools and speciation	Punctuated equilibrium was long considered an alternative theory of evolution and a challenge to the long established paradigm of Darwinian gradualism. How do paradigm shifts proceed in science and what factors are involved in their success?	
Animal physiology - Additional higher level (AHL)	Antibody production and vaccination		16 hours
	Movement		
	The kidney and osmoregulation		
	Sexual reproduction		
Option A – Neurobiology and behaviour (SL/HL)	Neural development The human brain Perception of stimuli Innate and learned behaviour Neuropharmacology Ethology		15 hours/ 25 hours
Option B – Biotechnology and	Microbiology: organisms in industry Biotechnology in agriculture		15 hours/ 25 hours

bioinformatics (SL/HL)	Environmental protection Medicine Bioinformatics	
Option C - Ecology and conservation (SL/HL)	Species and communities Communities and ecosystems Impact of humans on ecosystems Conservation of biodiversity Population ecology Nitrogen and phosphorus cycles	15 hours/ 25 hours
Option D – Human physiology (SL/ HL)	Human nutrition Digestion Functions of the liver The heart Hormones and metabolism Transport of respiratory gases	15 hours/ 25 hours

(More detailed content and specific skills, knowledge, concepts build and/or explored in unit planners)

E. ASSESSMENT

E.1 Assessment outline:

Assessment component	Weighting
External assessment SL (3 hours)	**80%**
Paper 1 (45 minutes) 30 multiple – choice questions on core material, about 15 of which are common with HL; the use of calculators is not permitted; no marks are deducted for incorrect answers.	20%
Paper 2 (1 hour 15 minutes) Data – based question; short – answer and extended – response questions on core material; one out of two extended response questions to be attempted by candidates; the use of calculators is permitted	40**%**
Paper 3 (1 hour) This paper will have questions on core and SL option material; Section A: candidates answer all questions, two to three short – answer questions based on experimental skills and techniques, analysis and evaluation, using unseen data linked to the core material Section B: short answer and extended – response questions from one option	20%

External assessment HL (4 hours 30 minutes) **Paper 1 (1 hour)** 40 multiple – choice questions on core and AHL material, about 15 of which are common with SL; the use of calculators is not permitted; no marks are deducted for incorrect answers. **Paper 2 (2 hours 15 minutes)** Data – based question; short – answer and extended – response questions on core and AHL material; two out of three extended response questions to be attempted by candidates; the use of calculators is permitted **Paper 3 (1 hour 15 minutes)** Section A: candidates answer all questions, two to three short – answer questions based on experimental skills and techniques, analysis and evaluation, using unseen data linked to the core material Section B: short answer and extended – response questions from one option	**80%** 20% 40% 20%
Internal assessment (10 hours) This component is internally assessed by the teacher and externally moderated by the IB at the end of the course. It enables students to demonstrate the application of their skills and knowledge, and to pursue their personal interests, without the time limitations and other constraints that are associated with written examinations. Students must write by themselves a scientific piece of work based on their investigation or data – based.	**20%**

The internal assessment criteria

The new assessment model uses five criteria to assess the final report of the individual investigation with the following raw marks and weightings assigned:

Personal engagement	Exploration	Analysis	Evaluation	Communication	Total
2 (8%)	**6 (25%)**	**6 (25%)**	**6 (25%)**	**4 (17%)**	**24 (100%)**

Levels of performance are described using multiple indicators per level. In many cases the indicators occur together in a specific level, but not always. Also, not all indicators are always present. This means that a candidate can demonstrate performances that fit into different levels. To accommodate this, the IB assessment models use markbands and advise examiners and teachers to use a **best-fit approach** in deciding the appropriate mark for a particular criterion.

Teachers should read the guidance on using markbands in the group 4 subject guides, in the section "Using assessment criteria for internal assessment" before starting to mark. It is also essential to be fully acquainted with the marking of the exemplars in the TSM. The precise meaning of the command terms used in the criteria can be found in the glossary of the subject guides.

Personal engagement

This criterion assesses the extent to which the student engages with the exploration and makes it their own. Personal engagement may be recognized in different attributes and skills. These could include addressing personal interests or showing evidence of independent thinking, creativity or initiative in the designing, implementation or presentation of the investigation.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below. **The evidence of personal engagement with the exploration is limited with little independent thinking, initiative or creativity.**
1	The justification given for choosing the research question and/or the topic under investigation does not demonstrate **personal significance, interest or curiosity**. There is little evidence of **personal input and initiative** in the designing, implementation or presentation of the investigation. **The evidence of personal engagement with the exploration is clear with significant independent thinking, initiative or creativity.**
2	The justification given for choosing the research question and/or the topic under investigation demonstrates **personal significance, interest or curiosity**. There is evidence of **personal input and initiative** in the designing, implementation or presentation of the investigation.

Exploration

This criterion assesses the extent to which the student establishes the scientific context for the work, states a clear and focused research question and uses concepts and techniques appropriate to the DP level. Where appropriate, this criterion also assesses awareness of safety, environmental, and ethical considerations.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
	The topic of the investigation is identified and a research question of some relevance is **stated but it is not focused**.
	The background information provided for the investigation is **superficial** or of limited relevance and does not aid the understanding of the context of the investigation.
1–2	The methodology of the investigation is only appropriate to address the research question to a very limited extent since it takes into consideration few of the significant factors that may influence the relevance, reliability and sufficiency of the collected data.
	The report shows evidence of limited awareness of the significant **safety**, ethical or environmental issues that are **relevant to the methodology of the investigation***.
	The topic of the investigation is identified and a relevant but not fully focused research question is described.
	The background information provided for the investigation is mainly appropriate and relevant and aids the understanding of the context of the investigation.
3–4	The methodology of the investigation is mainly appropriate to address the research question but has limitations since it takes into consideration only some of the significant factors that may influence the relevance, reliability and sufficiency of the collected data.
	The report shows evidence of some awareness of the significant **safety**, ethical or environmental issues that are **relevant to the methodology of the investigation***.
	The topic of the investigation is identified and a relevant and fully focused research question is clearly described.
	The background information provided for the investigation is entirely appropriate and relevant and enhances the understanding of the context of the investigation.
5–6	The methodology of the investigation is highly appropriate to address the research question because it takes into consideration all, or nearly all, of the significant factors that may influence the relevance, reliability and sufficiency of the collected data.
	The report shows evidence of full awareness of the significant **safety**, ethical or environmental issues that are **relevant to the methodology of the investigation***.

* This indicator should only be applied when appropriate to the investigation. See exemplars in TSM.

Analysis

This criterion assesses the extent to which the student's report provides evidence that the student has selected, recorded, processed and **interpreted** the data in ways that are relevant to the research question and can support a conclusion.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.
1–2	The report includes **insufficient relevant** raw data to support a valid conclusion to the research question. Some **basic** data processing is carried out but is either too **inaccurate or too insufficient to lead to a valid** conclusion. The report shows evidence of little consideration of the impact of measurement uncertainty on the analysis. The processed data is incorrectly or insufficiently interpreted so that the conclusion is invalid or very incomplete.
3–4	The report includes relevant but incomplete quantitative and qualitative raw data that could support a simple or partially valid conclusion to the research question. Appropriate and sufficient data processing is carried out that could lead to a broadly valid conclusion but there are significant inaccuracies and inconsistencies in the processing. The report shows evidence of some consideration of the impact of measurement uncertainty on the analysis. The processed data is interpreted so that a broadly valid but incomplete or limited conclusion to the research question can be deduced.
5–6	The report includes sufficient relevant quantitative and qualitative raw data that could support a detailed and valid conclusion to the research question. Appropriate and sufficient data processing is carried out with **the accuracy** required to enable a conclusion to the research question to be drawn that is fully **consistent** with the experimental data. The report shows evidence of full and appropriate consideration of the impact of measurement uncertainty on the analysis. The processed data is correctly interpreted so that a completely valid and detailed conclusion to the research question can be deduced.

Evaluation

This criterion assesses the extent to which the student's report provides evidence of evaluation of the investigation and the results with regard to the research question and the accepted scientific context.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below. A conclusion is **outlined** which is not relevant to the research question or is not supported by the data presented. The conclusion makes superficial comparison to the accepted scientific context.
1–2	Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **outlined** but are restricted to an **account** of **the practical** or **procedural issues** faced. The student has **outlined** very few realistic and relevant suggestions for the improvement and extension of the investigation. A conclusion is **described** which is relevant to the research question and supported by the data presented. A conclusion is described which makes some relevant comparison to the accepted scientific context.
3–4	Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **described** and provide evidence of some awareness of the **methodological issues*** involved in establishing the conclusion. The student has **described** some realistic and relevant suggestions for the improvement and extension of the investigation. A detailed conclusion is **described and justified** which is entirely relevant to the research question and fully supported by the data presented. A conclusion is correctly **described and justified** through relevant comparison to the accepted scientific context.
5–6	Strengths and weaknesses of the investigation, such as limitations of the data and sources of error, are **discussed** and provide evidence of a clear understanding of the **methodological issues*** involved in establishing the conclusion. The student has **discussed** realistic and relevant suggestions for the improvement and extension of the investigation.

*See exemplars in TSM for clarification.

Communication

This criterion assesses whether the investigation is presented and reported in a way that supports effective communication of the focus, process and outcomes.

Mark	Descriptor
0	The student's report does not reach a standard described by the descriptors below.

1–2	**The presentation of the investigation is unclear, making it difficult to understand the focus, process and outcomes.** The report is not well structured and is unclear: the necessary information on focus, process and outcomes is missing or is presented in an incoherent or disorganized way. The understanding of the focus, process and outcomes of the investigation is obscured by the presence of inappropriate or irrelevant information. There are many errors in the use of subject-specific terminology and conventions*.
3–4	**The presentation of the investigation is clear. Any errors do not hamper understanding of the focus, process and outcomes**. The report is well structured and clear: the necessary information on focus, process and outcomes is present and presented in a coherent way. The report is relevant and concise thereby facilitating a ready understanding of the focus, process and outcomes of the investigation. The use of subject-specific terminology and conventions is appropriate and correct. Any errors do not hamper understanding.

*For example, incorrect/missing labelling of graphs, tables, images; use of units, decimal places. For issues of referencing and citations refer to the “Academic honesty” section in the guide.