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| **Diploma Programme subject outline—Group 4: sciences** | | | | | | | | | | |
| **School name** | Lessing-Gymnasium Köln/Cologne, Germany | | | | | | **School code** | 003089 | | |
| **Name of the DP subject**  *(indicate language)* | Biology SL | | | | | | | | | |
| **Level**  *(indicate with X)* |  | | | | | | | | | |
| Higher |  | Standard completed in two years | | X | Standard completed in one year \* | | |  |  |
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| **Name of the teacher who completed this outline** | Silke Flüßhöh | | | **Date of IB training** | | | 21-23 February, 2014 | | | |
| **Date when outline was completed** | 30 October, 2017 | | | **Name of workshop**  *(indicate name of subject and workshop category)* | | | Subject Specific Seminar: Biology (Category 3) | | | |

\* All Diploma Programme courses are designed as two-year learning experiences. However, up to two standard level subjects, excluding languages ab initio and pilot subjects, can be completed in one year, according to conditions established in the *Handbook of procedures for the Diploma Programme*.

##### Course outline

* + Use the following table to organize the topics to be taught in the course. If you need to include topics that cover other requirements you have to teach (for example, national syllabus), make sure that you do so in an integrated way, but also differentiate them using italics. Add as many rows as you need.
  + This document should not be a day-by-day accounting of each unit. It is an outline showing how you will distribute the topics and the time to ensure that students are prepared to comply with the requirements of the subject.
  + This outline should show how you will develop the teaching of the subject. It should reflect the individual nature of the course in your classroom and should not just be a “copy and paste” from the subject guide.
  + If you will teach both higher and standard level, make sure that this is clearly identified in your outline.

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|  | **Topic/unit**  (as identified in the IB subject guide)  *State the topics/units in the order you are planning to teach them.* | **Contents** | **Allocated time** | | | **Assessment instruments to be used** | **Resources**  *List the main resources to be used, including information technology if applicable.* |
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| One class is | 45 | minutes. |
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| In one week there are | 4-5 | classes. |
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| Year 1 | **Cell Biology and**  **Molecular Biology I** | Cell Theory / Origin of cells  Microscopes (TEM/SEM/LM)  Ultrastructure of pro- and eukaryotic cells  Chemistry of Life I: properties of water; lipids, carbohydrates, proteins  Membrane structure and transport through membranes (active and passive) | ca. 20 classes + practical activities | | | The external assessment, which is required by the IBO, consists of three written papers. The internal assessment consists of the practical scheme of work (PSOW) and the interdisciplinary project.  Apart from these assessments the students will also take two written exam papers in each semester. Throughout the 2 year course there will be seven exam papers which will cover a range of topics (reference “German curriculum”). The resulting grades will count towards the final grade of the German Abitur. The exam topics cover relevant IB topics and therefore also serve as regular and detailed feedback for our students.  An oral assessment will also be given each semester, which includes the students oral contributions in class as well as evaluations of certain skills such as, for example, scientific drawings or data processing. After two years the students will take their Abitur at more or less the same time as their IB exams. | For this course students will get a copy of the following books:  Allot, A. and Mindorff, D.: *Biology Course Companion*, OUP, 2014.  Greenwood, T.: *IB Biology Student Workbook*, Biozone, 2014.  Information technology:  CASSY-pack-E by Leybold Didactic (data logging device)  Computer access is given (computers have office software and internet access) |
| **Cell Biology and**  **Molecular Biology II** | Cell division I: Mitosis  Chromosomes  Chemistry of life II: DNA  Replication / Meselson and Stahl experiments  (according to our national curriculum *transcription and translation* is taught integrated in the genetics topic) | ca. 15 classes + practical activities | | |
| **Cell Biology and**  **Molecular Biology III** | Metabolism  Chemistry of life III: proteins  Enzyme reactions  *Human physiology:* Digestion and absorption (according to the national curriculum)  Cell respiration  (according to our national curriculum the topic *photosynthesis* is taught integrated in the ecology topic) | ca. 15 classes + practical activities | | |
| **Genetics** | Cell division II: Meiosis  Karyotypes  Genes and chromosomes  From gene to protein: transcription and translation (according to our national curriculum)  Gene mutations  Inheritance  Genetic modification and biotechnology | 20 classes + practical activities | | |
| **Biological investigation (IA)** | Chosen by student | 10 hours | | | In addition to their Biology course following the national curriculum the IB students visit a practical course which focuses on the practical IB requirements (practical skills and internal assessment) and the biological investigation (IA).  During the first year, IA assessments will begin using IB grading criteria and mark schemes. |
| **Group 4 project** | Former example umbrella topics:   * Olympic games * Bionics * Plastic bags * Climate change | 10 hours | | |  |
| Year 2 | **Ecology and conservation**  **(Core and option)** | Species, communities - and ecosystems  Photosynthesis (according to the national curriculum)  Energy flow in various ecosystems (food chains and food webs)  Impacts of humans on ecosystems (e.g pest control, fishing, agriculture and biodiversity)  Carbon cycling climate change  Conservation and biodiversity | ca. 40 classes + practical acitivities | | | Compare year 1 | Compare Year 1  For their exam preparation students will get a copy of: Allot, A.: *Biology Study Guide: 2014 edition: Oxford IB Diploma Program*, OUP, 2014. |
| **Evolution and biodiversity** | Mechanisms of evolution: (genetic) variation, natural selection, species and speciation, adaptive radiation  Classification of biodiversity  Evidence for evolution: fossil findings, morphological and molecular homologies  Cladistics | ca. 16 lessons + practical activities | | |
| **Human physiology** | The blood system and gas exchange  Defence against infectious disease  Neuronal transmission: From stimulus to reaction  Homeostasis  Hormones  Reproduction | ca. 25 classes + practical activities | | |

##### The group 4 project

As the IB guides say, “The group 4 project is a collaborative activity where students from different group 4 subjects work together on a scientific or technological topic, allowing for concepts and perceptions from across the disciplines to be shared in line with aim 10—that is, to ‘encourage an understanding of the relationships between scientific disciplines and the overarching nature of the scientific method.’” Describe how you will organize this activity. Indicate the timeline and subjects involved, if applicable.

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| The group 4 project takes place near the end of the year 1. For the last years it has been carried out as a collaborative project with Deutsche Schule London (DSL). DSL offers Biology, Chemistry and Physics courses. The participating teachers make sure that groups are formed that consist of students from both schools and different group 4 subject courses. The students communicate with each other using video conferences and email.  The umbrella topics are chosen that allow students to carry out interdisciplinary investigations. Umbrealla topics of the last few years were, e.g. bionics, Olympic games, carrier bags, Ig® Nobel prize  **Timeline**   1. **Introduction:** Students will discuss the umbrella topic and find individual topics within the given topic. Students of both schools get in contact and groups will be formed. 2. **Planning and action phase:** The collaborative groups will plan and research their actions following the scientific method (research question, hypothesis, design of an experiment, data collection, data processing, conclusion, evaluation) 3. **Action Day:** The collaborative groups will complete their research, gather data and pool their data. 4. **Evaluation phase:** The groups will evaluate their data and resources used and produce a display product (*scientific poster* and oral presentation). 5. **Science fair:** The students present and discuss their collaborative results at a science fair. Students invite interested students, teachers and pre-IB-students. 6. **Reflection:** The students are encouraged to reflect on their *personal skills* in their reflective statement. |

##### IB practical work and the internal assessment requirement to be completed during the course

As you know, students should undergo practical work related to the syllabus.

* Physics, chemistry and biology: 40 hours (at standard level) or 60 hours (at higher level)
* Computer science: 40 hours (at standard level) or 40 hours (at higher level)
* Design technology: 60 hours (at standard level) or 96 hours (at higher level)
* Sport, exercise and health science: 40 hours (at standard level) or 60 hours (at higher level)

Use the table below to indicate the name of the experiment you would propose for the different topics in the syllabus.

An example is given. Add as many rows as necessary.

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| **Name of the topic** | **Experiment** | **Any ICT used?**  *Remember you must use all five within your programme.* |
| Acids and bases | Titration | Yes |
| Cell biology | How to use a light microscope |  |
| Microscopy and drawing of red onion cells, plant tissues (cross-section of a leaf), human cheek cells; Drawing of eukaryotic and procaryotic cells |  |
| Calculation of the magnification of drawings and the actual size of structures shown in drawings or in micrographs |  |
| Estimation of osmolarity of potato and sweet potato tissues by using the weighing method |  |
| Mircoscopy: Illustrating the function of the cytoskeleton by observing cytoplasmic streaming in *Elodea* |  |
| Microscopy: Plasmolysis and deplasmolysis in epidermis cells of the red onion |  |
| Molecular Biology / Digestion and absorption | Digestion of fat: Measuring lipase activity with and without bile by monitoring the pH (pH probe, phenolphthalein, bromthymol blue) | Data logging, graph plotting software, spreadsheet |
| Digestion of proteins: Measuring pepsin activity at different pH values (using biuret to test for enzyme activity) |  |
| Digestion of starch: Designing quantitative experiments to investigate the parameters of amylase activity (iodine and Fehling's test) |  |
| Digestion of urea: Designing quantitative experiments to inverstigate the parameters of Urease activity (Conductivity, temperature and substrate saturation, buffer/pH) | Data logging, graph plotting software, spreadsheet |
| Photosynthesis | Chromatography of chlorophyll pigments |  |
| Demonstration: Absorption with chlorophyll | Graph plotting software |
| Effect of light intensity on photosynthesis | Spreadsheet, graph plotting software, computer simulation |
| Factometer: Investigating the effect of CO2-concentration on photosynthesis by measuring the O2-volume released by Cabomba | Graph plotting software, spreadsheet |
| Species, communities, ecosystems, energy flow | Setting up mesocosms to try to establish sustainability |  |
| Constructing foodwebs |  |
|  | Analysing and comparing quality of water samples obtained from a nearby river and pond. | Spreadsheet, graph plotting software |
| Molecular Biology / Genetics | DNA extraction from different kinds of vegetables and fruits |  |
| Cell Biology / Genetics | Computer simulation: Identifying and comparing the different stages of mitosis and meiosis | Computer simulation |
| Genetics / Inheritance | Tutorial: Analysis of pedigree charts / Working with a computer simulation program; Deducing genotypes | Computer simulation |
| Analysing karyograms (e.g. male, female, Trisomy 21, Turner syndrome, Klinefelder syndrome) |  |
| Using Punnett grids to predict the outcomes of monohybrid genetic crosses |  |
| Genetics / Biotechnology | BayLab: Investigation of the microsatellite locus D1S80 on chromosome 1: extraction of DNA from human cheek cells, cutting of DNA with restriction enzymes, PCR, gel electrophoresis |  |
| Human physiology / Blood system | Dissection of a pig's heart |  |
| Recording and analysing an electrocardiogram with CASSY | Data logging, graph plotting software |
| Microscopy: Identifying blood vessels (prepared microscopic slides) |  |
| Measuring blood pressure |  |
| Human physiology / Gas exchange | Ventilation experiments: Monitoring ventilation in humans at rest and after mild and vigorous exercise | Data logging (Cassy), graph plotting software |
| Human physiology / Neurons and synapses | USSING-chamber: Model experiment to investigate a neurone’s membrane permeability and resting potential | Data logging (Cassy), graph plotting software |
| Microscopy: motor neurones, cross-sections of the spinal cord |  |
| Mouse party: Working with a computer simulation program: Psychoactive drugs and their effect on signal transmission | Computer simulation |
| Human physiology / Reproduction | Reproduction: The menstrual cycle is controlled by negative and positive feedback mechanisms |  |
| Evolution | Industrial melanism: Investigation on how natural selection leads to evolution | Computer simulation |
| Classification: Using a dichotomous key to identify the six main phyla of invertebrates |  |
| Classification: Construction of dichotomous keys to identify sharks |  |
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##### Laboratory facilities

Describe the laboratory and indicate whether it is presently equipped to facilitate the practical work that you have indicated in the chart above. If it is not, indicate the timeline to achieve this objective and describe the safety measures that are applicable.

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| There is adequate instructional space for the group 4 course. There are two laboratories with eight lab benches each. There are sinks next to each lab bench and adequate cabinet space to store laboratory equipment and supplies. Each lab bench has gas connection and sockets to provide power for microscopes, wather baths, heat lamps, etc. A refrigerator to store and cool biological supplies is also available. Each room is equipped with projection equipment that can be connected to computers and data logging devices.  The science laboratories have basic equipment to accomplish the above mentioned labs. Further purchases will be made. As our school is located in a densely populated urban area there are several external laboratories that can be booked for specific experiments that exceed our school lab’s capabilities (mostly genetics, e.g. “Baylab”).  **Safety equipment:** Goggles and gloves can be provided for individual student use. An eyewash station and a first-aid kit are available. Fire extinguishers are located in every room and a fire blanket is available. Safety switches in each room can be used to disconnect equipment quickly from gas and electricity. Acids, bases and other chemicals are kept safely in lockable cabinets outside of the classrooms. |

##### Other resources

Indicate what other resources the school has to support the implementation of the subject and what plans there are to improve them, if needed.

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| The school does not subscribe to appropriate scientific periodicals and journals. However, the library has an adequate stock of updated resources in life and physical sciences which is being expanded. |

##### Links to TOK

You are expected to explore links between the topics of your subject and TOK. As an example of how you would do this, choose one topic from your course outline that would allow your students to make links with TOK. Describe how you would plan the lesson.

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| **Topic** | **Link with TOK (including description of lesson plan)** |
| Defense against infectious disease | Introduce students to controversy about vaccinations (e.g.: anti-Vaccination posts on social media claiming there is a link between vaccinations and autism) and contrast this with recent (and in some cases lethal) outbreaks of measles, e.g. in Berlin. Initial Discussion, extract knowledge questions, e.g. *How reliable can medical research be when it comes to both benefits and risks of vaccinations, and how can correlation and causation be distinguished? Can collective benefits of immunisations (herd immunity, medical costs, disease prevention) legitimize obligatory vaccinations? What role should the state play in the medical decisions of its citizens (paternalism debate, issues of informed consent)?* In following lesson: Research and debate (e.g. British Parliamentary) on one these knowledge questions , coordinated with TOK teacher (ideally students have already covered the fundamentals of ethics (utilitarianism vs deontology). Possible links/extensions: Scientific method, double blind studies, role of statistics for medical research, science vs pseudoscience. |

##### Approaches to learning

##### Every IB course should contribute to the development of students’ approaches to learning skills. As an example of how you would do this, choose one topic from your outline that would allow your students to specifically develop one or more of these skill categories (thinking, communication, social, self-management or research).

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| **Topic** | **Contribution to the development of students’ approaches to learning skills (including one or more skill category)** |
| Homeostasis – Control of blood glucose, diabetes type I and II | Integral to the experience of students in the Biology SL course is their experience in the classroom laboratory or in the field. Practical activities allow students to interact directly with natural phenomena and secondary data sources. These experiences provide the students with the opportunity to design investigations, collect data, develop manipulative skills, analyse results, collaborate with peers and evaluate and communicate their findings.  One example for students to specifically develop their ***communication*** and ***collaboration*** skills is outlined in the following:   * **Jigsaw activity phase I:** The course is divided into three groups. The students of each expert group use their text books to research a different subtopic. (*ATL: Read for comprehension and information; skim texts to build understanding*)   **Group 1:** Control of blood glucose concentration – Create a diagram that shows how blood glucose levels are controlled. Be able to present your findings. (*ATL: Organize and depict information logically*)  **Group 2:** Explain how the control of blood glucose concentration is disturbed in people with diabetes type I. Refer to onset, causes, symptoms, treatment, effects on everyday life. Be able to present your findings. (*ATL: Organize and depict information logically*)  **Group 3:** Explain how the control of blood glucose concentration is disturbed in people with diabetes type II. Refer to onset, causes, symptoms, treatment, effects on everyday life. Be able to present your findings. (*ATL: Organize and depict information logically*)  In their respective groups the students plan a diagram and short presentation in order to be able to present their findings and inform the other groups of their results. The students of each group become experts for their respective subtopics. In these expert groups they can clarify difficult points, help each other, prepare and rehearse the presentation they are going to give. (*ATL: Structure information; manage and resolve problems and work collaboratively in teams; encourage others to contribute; give and receive meaningful feedback; advocate for one’s own rights and needs*)   * **Jigsaw activity phase II:** The students form new groups (home groups) that consist of one expert each. The experts are now responsible for teaching their fellow students what they have researched using their presentation they have prepared in their expert groups. The other group members ask questions and they all discuss their results. (*ATL: Use speaking techniques and media to communicate with an audience; make interferences and draw conclusions, negotiate ideas and knowledge with peers*) * **Jigsaw activity phase III:** On the basis of their entire expert knowledge the students discuss in their home groups differences between type I and type II diabetes and discuss central risk factors for type II diabetics and measures how the onset of type II diabetics can be prevented. They summarise their findings in an action plan for patients with a predisposition for diabetes type II. Finally they present and discuss their findings in class. (*ATL: Manage and resolve problems and work collaboratively in teams; encourage others to contribute; give and receive meaningful feedback; advocate for one’s own rights and needs; negotiate ideas and knowledge with peers; structure information; use speaking techniques and media to communicate with an audience)* |

##### International mindedness

Every IB course should contribute to the development of international-mindedness in students. As an example of how you would do this, choose one topic from your outline that would allow your students to analyse it from different cultural perspectives. Briefly explain the reason for your choice and what resources you will use to achieve this goal.

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| **Topic** | **Contribution to the development of international mindedness (including resources you will use)** |
|  | The course is taught in English which is, for the majority of our students, not their first language. They will develop a very good command of English. This is especially important, as English is used as lingua franca, in particular in sciences. Their grasp of English therefore empowers them to access a much wider range of scientific literature on any given topic, contributed by scientists from all across the globe as opposed to just the German-speaking scientific community. |
| Defence against infectious disease | Epidemiologists face several problems that require international solutions. These problems are, for example, antibiotic resistant bacteria, flu strains that quickly change and spread quickly due to human mobility and migration. Refugees and victims of natural catastrophes need proper sanitary conditions for food and water consumption. In order to approach these challenges international study and cooperation is necessary especially in order to provide clean drinking water.  Resources: IB course book, <http://www.who.int/cholera/en/>, <http://www.who.int/antimicrobial-resistance/en/>, <http://www.who.int/influenza/gisrs_laboratory/flunet/en/> |

##### Development of the IB learner profile

Through the course it is also expected that students will develop the attributes of the IB learner profile. As an example of how you would do this, choose one topic from your course outline and explain how the contents and related skills would pursue the development of any attribute(s) of the IB learner profile that you will identify.

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| **Topic** | **Contribution to the development of the attribute(s) of the IB learner profile** |
| Ecology / Molecular Biology - Photosynthesis | In studying photosynthesis and by planning and carrying out experiments to investigate abiotic factors affecting photosynthesis many IB Learner Profile attributes can be studied. First, the students need to be ***Inquirers***. They ask themselves why scientists explore photosynthesis and why knowledge about photosynthesis is relevant for their everyday life (***Knowledgeable***). Further they think about methods by which scientists explore factors that have an effect on photosynthesis. Then they formulate a question that can be used to generate data for further analysis. On the basis of their knowledge students are confident enough to make predictions and construct hypotheses even though they might be wrong (***Risk-takers***).  Once the data has been collected, that students are ***Thinkers*** to critically analyse their results (***Reflective***). This can lead to further questions, or it can help the student to make informed decisions about complex problems. Once the data has been analysed and evaluated the students are ***Communicators*** to present the information in a way that others can understand. They can use more than one language (English, German and their first language) to present their data, results and conclusions. Students use a variety of modes of communication (lab reports, displays, multi-media, etc.) to present findings and pass on their findings and knowledge to peers and teachers. |