Diploma Programme subject outline—Group 4: Sciences			
School name	Alruwad International School	**School code**	060563
Name of the DP subject	Biology- English		
Level	Higher Level X	Standard Level	
Name of the teacher who completed this outline	Gloria Malagon	**Date of IB training**	August 14 to September 11, 2019
Date when outline was completed	Oct 2019	**Name of workshop**	Biology: A focus on internal assessment (Cat.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*.

Formative assessments will be given in the form of:	**Summative assessments will be given in the form of:**	**Differentiation will be mostly focused on:**
● Entry and exit tickets ● Worksheets ● Quizzes ● Think-pair-share ● Find someone who ● Asking higher order questions ● Cooperative learning ● Presentations, Kahoots ● Quizlet, and Gimkit ● using graphic organizers, etc.	● Exams ● Quizzes ● Investigations ● Laboratories´ design ● Internal assessment ● Practical work ● Solving Problems ● Projects ● Presentations ● Portfolio	● Language proficiency (reading and writing) ● Language acquisition (vocabulary) ● Thinking development (Critical thinking and problem solving) ● Problem solving and scientific skills (scaffolding)

1. Course outline

	TOPIC / UNIT	CONTENT	ALLOCATED TIME One class is 50min Class/week 5	Assessment Instruments to be used	Prescribed practical's	**Resources** *List the main resources to be used, including information technology if applicable.*
Year 1	1. Cell biology Assessment Objectives 1-7 Assessment Statements 1.1, 1.2, 1.3, 1.4, 1.5, 1.6	1.1 Introduction to cells 1.2 Ultrastructure of cells 1.3 Membrane structure 1.4 Membrane transport 1.5 The origin of cells 1.6 Cell division	**15 h**	Lab Notebook Reports (all labs) Lab and Activity **Paper 3** Participation Model Building and Evaluation **Paper 3** Written Papers In Class Quiz- short answer **Paper 2**, Multiple Choice **Paper 1.** Homework- research, writing, video, diagrams Unit Test- short answer **Paper 2**, essay, multiple choice **Paper 1**	Use of a light microscope to investigate the structure of cells and tissues, with drawing of cells. Calculation of the magnification of drawings and the actual size of structures and shown in drawings or micrographs. Estimation of osmolarity in tissues by bathing samples in hypotonic and hypertonic solutions.	**IB Biology Course Book: Andrew Allott** Author(s): Andrew Allott, David Mindorff ISBN-13: 9780198392118 ISBN-10: 0198392117 Publisher: Oxford University Press Publication Date: 06-Feb-14 Biozone IB Biology BioNinja App CrashCourse Biology See resources below
	2. Molecular biology	2.1 Molecules to metabolism 2.2 Water 2.3 Carbohydrates and lipids	**21 h**			

	Assessment Objectives 1-7 Assessment Statements 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 , 2.8, 2.9, 8.1, 8.2, 8.3 8. Metabolism, cell respiration and photosynthesis 3. Genetics 1.6, 3.1, 3.2, 3.3, 3.4, 3.5, 7.1 , 7.2, 7.3, 10.1, 10.2, 10.3 7. Nucleic acids	2.4 Proteins 2.5 Enzymes 2.6 Structure of DNA and RNA 2.7 DNA replication, transcription and translation 2.8 Cell respiration 2.9 Photosynthesis 8.1 Metabolism 8.2 Cell respiration 8.3 Photosynthesis 3.1 Genes 3.2 Chromosomes 3.3 Meiosis 3.4 Inheritance 3.5 Genetic modification and biotechnology 7.1 DNA structure and replication 7.2 Transcription and gene expression 7.3 Translation	**14 h** **15 h** **9 h**	Presentations and Public Speaking See above chart on: **1. Formative assessments will be given in the form of.** **2. Summative assessments will be given in the form of.** **3. Differentiation will be mostly focused on.**	Experimental investigation of a factor affecting enzyme activity. Experimental investigation of photosynthesis using a Potometer.	

	10: Genetics and evolution Practical scheme of work Practical activities Individual investigation (internal assessment–IA) Group 4 project Assessment Objectives 1-7	10.1 Meiosis 10.2 Inheritance 10.3 Gene pools and speciation	**8 h** **60 H** **20 h** **5 h** **10 h**	Group 4 Project - September 29 – October 2, 2021		

Year 2	4. Ecology Assessment Objectives 1-7 Assessment Statements 4.1, 4.2, 4.3, 4.4 5. Evolution and biodiversity Assessment Objectives 1-7 Assessment Statements 5.1, 5.2, 5.3, 5.4, 9: Plant biology Assessment Objectives 1-7	4.1 Species, communities and ecosystems 4.2 Energy flow 4.3 Carbon cycling 4.4 Climate change 5.1 Evidence for evolution 5.2 Natural selection 5.3 Classification of biodiversity 5.4 Cladistics 9.1 Transport in the xylem of plants	**12 h** **12 h** **13 h**	Lab Notebook Reports (all labs) Lab and Activity **Paper 3** Participation Model Building and Evaluation **Paper 3** Written Papers In Class Quiz- short answer **Paper 2**, Multiple Choice **Paper 1.** Homework- research, writing, video, diagrams Unit Test- short answer **Paper 2**, essay, multiple choice **Paper 1** Presentations and Public Speaking	Setting up sealed mesocosms to try to establish sustainability	http://biostathandbook.com/testchoice.html https://studynova.com/free-ib-resources/ (not free) 2. https://blog.prepscholar.com/the-best-ib-biology-study-guide-and-notes-for-sl-and-hl 3. https://drive.google.com/open?id=1y-3USdcnMPkemGGtOtPqpF-p31ZTJ2ay, InThinking summary notes to fill in. TEACHER'S RESOURCE: 1. https://www.biointeractive.org/classroom-resources/data-points-guide (data analysis) 2. http://datanuggets.org/ (for data analysis based activities) 3. https://www.biointeractive.org/home (Empowering educators, inspiring students)- Case studies

	Assessment Statements 2.9, 8.3, 9.1, 9.2, 9.3, 9.4 6. Human physiology Assessment Objectives 1-7 Assessment Statements 6.1, 6.2,6.3, 6.4, 6.5, 6.6, 11.1, 11.3, 11.2, 11.4, D.1, D.2, D.3, D.4, D.5, D.6 Option D. Human physiology 11: Animal physiology	9.2 Transport in the phloem of plants 9.3 Growth in plants 9.4 Reproduction in plants 6.1 Digestion and absorption 6.2 The blood system 6.3 Defense against infectious disease 6.4 Gas exchange 6.5 Neurons and synapses 6.6 Hormones, homeostasis and reproduction D.1 Human nutrition D.2 Digestion D.3 Functions of the liver D.4 The heart D.5 Hormones and metabolism - HL	**20 h** **25 h**	See above chart on: 1. Formative assessments will be given in the form of. 2. Summative assessments will be given in the form of. 3. Differentiation will be mostly focused on.	Monitoring of ventilation and heart rate in humans at rest and after mild and vigorous exercise.	http://datanuggets.org/, For example fly genetics https://drosophilab.software.informer.com/ . species conservation https://scti.tools/ and population biology and evolutionary ecology https://cbs.umn.edu/populus/download-populus got these websites for this RQ (which need to be more specific): https://data.oecd.org/agroutput/meat-consumption.htm https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3819990/ http://www.ehnheart.org/images/CVD-statistics-report-August-2017.pdf

		D.6 Transport of respiratory gases- HL	**16 h**			
		11.1 Antibody production and vaccination				
	Practical scheme of work	11.2 Movement 11.3 The kidney and osmoregulation				
		11.4 Sexual reproduction				
	Practical activities		**20 h**			
	Individual investigation (internal assessment–IA)					
	Assessment Objectives 1-7		**5h**	1st Draft - January 23,2022		
	Assessment Statements			Final IA - February 9, 2022		
	Internal Assessment					

The recommended teaching time is 150 hours to complete SL courses as stated in the document General regulations: Diploma Programme for students and their legal guardians (2011) (page 4, Article 8.2).

2. 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.

The group 4 project is a collaborative activity where students from different group 4 subjects (Physics, Chemistry, Biology and Environmental Science and Society) 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. The Group 4 project will take place in the second half of the first year, with the exact date to be determined through discussion with the other IB teachers to avoid ove The timeline and subject involved is unclear to me at this point, however, it will take place at the beginning of the second year to avoid overloading the students. The total time allocated to this project shall be 10 hours.

Year 1- First trimester – Teachers Working cooperatively: (2 meetings/3 hours)

- Review Group 4 activity requirements and PSOW.
- Work on identifying attributes of the learner profile, the 5 approaches to learning, and skills in chemistry.
- Define the role of the NOS and international mindedness.
- Review examples of previous projects, identify logistical strategies, project stages, and addressing aims 7 and 8.

Year 1- Second Trimester: Teachers working cooperatively (2 meetings/3 hours)

- Review the design technology cycle or design thinking strategies and start planning stages
- Use the group 4 and presentation´s assessment criteria to design assessment tools (Assessment check lists and rubrics)
- Create a group four guideline-toolbox written or electronic to guide student´s work

Year 1- Third Trimester: Teachers and students working cooperatively (2 meetings/2 hrs.)

- Planning stages, assessment and toolbox
- Team-building exercise
- Brainstorm/survey/share ideas for topic
- Decide on final topic

Year 2- Beginning of the year: Group 4 project development- Students mostly working by themselves (10 hours)

- Guide students and emphasize interdisciplinary cooperation and the scientific process.
- Frequent project feedback and reminders
- Prepare for Evaluation presentation and requirements (Assessment check lists and rubrics)
- Conclude Evaluation loading the students. The total time allocated to this project shall be 10 hours.

3. IB practical work and the internal assessment requirement

As you know, students should undergo practical work related to the syllabus. Students should undergo 40 hours (at standard level) or 60 hours (at higher level) of practical work related to the syllabus.
Use the table below to indicate the name of the experiment you would propose for the different topics in the syllabus.
Basic: **Paper 2 and 3**

Name of the topic	Experiment / Activity	ICT use
1. Cell biology	Use of a light microscope to investigate the structure of cells and tissues, with drawing of cells – Practical 1	
	Estimation of osmolarity in tissues by bathing samples in hypotonic and hypertonic solutions. – Practical 2	
2. Molecular biology	Experimental investigation of a factor affecting enzyme activity.-Practical 3	Data logging
8. Metabolism	Separation of photosynthetic pigments by chromatograph – Practical 4	Modeling and Simulations
4. Ecology	Setting up sealed mesocosms to try to establish sustainability.	
6. Human physiology	Monitoring of ventilation and heart rate in humans at rest and after mild and vigorous exercise.	Spreadsheets and Graphing
9. Plants	Measurement of transpiration rates using potometers	Spreadsheets and Graphing

Also:

Name of the topic	Experiment / Activity	ICT use
1.5 The origin of cells	Pasteur's experiment can be repeated using modern apparatus.	
2.1 Molecules to metabolism	ICT can be used for molecular visualization of carbohydrates, lipids and proteins in this sub-topic and in 2.3 and 2.4. Food tests such as the use of iodine to identify starch or Benedict's reagent to identify reducing sugars could be carried out.	Data logging
3.1 Genes	Use of a database to compare DNA base sequences.	Databases

3.2 Chromosomes	Staining root tip squashes and microscope examination of chromosomes is recommended but not obligatory. Use of databases to identify gene loci and protein products of genes.	Databases
4.4 Climate change	Databases can be used to analyze concentrations of greenhouse gases	Databases
6.2 The blood system	A heart dissection is suggested as a means of studying heart structure.	
8.1 Metabolism	Experiments on enzyme inhibition can be performed. Computer simulations on enzyme action including metabolic inhibition are available	Modeling and Simulations
9.1 Transport in the xylem of plants	Measurement of stomatal apertures and the distribution of stomata using leaf casts, including replicate measurements to enhance reliability	
10.1 Meiosis	Staining of lily anthers or other tissue containing germ-line cells and microscope examination to observe cells in meiosis	

Data Loggers and sensor will be made available at the start of the program (August 2021):

Vernier Sensors:
Blood Pressure sensor
CO_2 Gas sensor
Colorimeter
Heart Rate sensor
Light sensor
O_2 Gas sensor
pH sensor
Temperature sensor
Spirometer

Data Logger:
LabQuest 2

4. 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.

The laboratory is a fully equipped high school science facility. Seating is around 6 large tables. There is a long countertop along one wall with two full sinks and adequate cabinet space to store laboratory equipment and supplies. Overhead, retractable power cords provide power for equipment, etc. The room is also equipped with projection tools and a smart board to accommodate a variety of presentations. Safety equipment including goggles, aprons, gloves, etc. are provided for individual student use and a fire blanket is available. A portable eyewash station and an emergency shower are provided as for the safety list items. Given the expanded list of laboratories required for the HL chemistry course, some equipment and laboratory supplies will be necessary, but are within budget for the first year of the course(August 2020).

5. 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.

The school has a well-supplied science stockroom with adequate Biology supplies. Some equipment, such as microscopes and hot plates is shared among teachers in the department, but there is enough to accommodate needs. There are 2 computer labs with internet access that will allow students to access any necessary digital programs as part of the course. The library has excellent reference materials in both print and digital form and the librarians are knowledgeable about the research resources available. Additionally, the campus is well situated to allow for access to a local natural area for field related observations and the University of Sultan, with a variety of accessible science labs and Biology lectures.

6. Links to TOK

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.

Topic	Link to TOK
2. Molecular Biology Knowledge and Technology	Claims about the "memory of water" have been categorized as pseudoscientific. After this unit has been studied we will have a debate backing up different points of view that answer the following questions: 1. What are the criteria that can be used to distinguish scientific claims from pseudoscientific claims? There are conflicting views as to the harms and benefits of fats in diets. 2. How do we decide between competing views? 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 of techniques requires financial investment. 3. Should knowledge be shared when techniques developed in one part of the world are more applicable in another? The story of the elucidation of the structure of DNA illustrates that cooperation and collaboration among scientists exists alongside competition between research groups. 4. To what extent is research in secret 'anti-scientific'? 5. What is the relationship between shared and personal knowledge in the natural sciences?

7. 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).

The aims of approaches to teaching and learning in the Diploma Programme are to:

- empower teachers as teachers of learners as well as teachers of content
- empower teachers to create clearer strategies for facilitating learning experiences in which students are more meaningfully engaged in structured inquiry and greater critical and creative thinking
- promote both the aims of individual subjects (making them more than course aspirations) and linking previously isolated knowledge (concurrency of learning)
- encourage students to develop an explicit variety of skills that will equip them to continue to be actively engaged in learning after they leave school, and to help them not only obtain university admission through better grades but also prepare for success during tertiary education and beyond
- enhance further the coherence and relevance of the students' Diploma Programme experience
- allow schools to identify the distinctive nature of an IB Diploma Programme education, with its blend of idealism and practicality.

The five approaches to learning (developing thinking skills, social skills, communication skills, selfmanagement skills and

research skills) along with the six approaches to teaching (teaching that is inquirybased, conceptually focused, contextualized, collaborative, differentiated and informed by assessment) encompass the key values and principles that underpin IB pedagogy.

Topic	Contribution to the development of students' approaches to learning skills (including one or more skill category)	ATL
4.1 Species, communities and ecosystems	• Classifying species as autotrophs, consumers, detritivores or saprotrophs from a knowledge of their mode of nutrition. • Setting up sealed mesocosms to try to establish sustainability. (Practical 5) • Testing for association between two species using the chi-squared test with data obtained by quadrat sampling. • Recognizing and interpreting statistical significance.	RESEARCH SKILLS •Hypothesis – mesocosms •ID/Control of Variables – Mesocosms •Observing/Measuring- Mesocosms •Research/Writing – THINKING SKILLS •Graphing •Interpreting Graphs- •Statistics •Evaluation – Mesocosms COMMUNICATION SKILLS •Technology- Moodle, Office365 SOCIAL SKILLS •Collaboration- lab groups, dissections SELF MANAGEMENT SKILLS •Safety- lab work •Informed Choice – Homework options
4.2 Energy flow	• Quantitative representations of energy flow using pyramids of energy.	
4.3 Carbon cycling	• Estimation of carbon fluxes due to processes in the carbon cycle. • Analysis of data from air monitoring stations to explain annual fluctuations. • Construct a diagram of the carbon cycle.	
4.4 Climate change	• Threats to coral reefs from increasing concentrations of dissolved carbon dioxide. • Correlations between global temperatures and carbon dioxide concentrations on Earth. • Evaluating claims that human activities are not causing climate change.	

8. 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 analyze it from different cultural perspectives. Briefly explain the reason for your choice and what resources you will use to achieve this goal.

Topic	Contribution to the development of international mindedness
1. Cell biology	We will compare cultures that are commonly known in Oman: Arabic, European and American. Ethical points of view and religious understandings concerning: Stem cell research has depended on the work of teams of scientists in many countries who share results thereby speeding up the rate of progress. However, national governments are influenced by local, cultural and religious traditions that impact on the work of scientists and the use of stem cells in therapy. Microscopes were invented simultaneously in different parts of the world at a time when information travelled slowly. Modern-day communications have allowed for improvements in the ability to collaborate, enriching scientific endeavor. Biologists in laboratories throughout the world are researching into the causes and treatment of cancer. Resources: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2726839/ https://www.youtube.com/watch?v=9roSzMrdGdY

“The aim of all IB programs is to develop internationally minded people, who, recognizing their common humanity and shared guardianship of the planet, help to create a better and more peaceful world.”

Science has always been an international endeavor and modern global science has been the result of the interchange of ideas across national boundaries over the centuries. The contributions of many different civilizations, for example, Indian, Chinese and Arabic, over time have been essential in the development of science. Teachers are encouraged to emphasize this contribution in their teaching of various topics, perhaps through the use of timeline websites.

www2.gsu.edu/~mstnrhx/9870/science.htm
trailblazing.royalsociety.org/
www.physics.ohio-state.edu/~wilkins/science/sctmln.html
en.wikipedia.org/wiki/Category:Science_timelines

9. 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.

Topic	Contribution to the development of the attribute(s) of the IB learner profile
Ecology and Conservation	Caring Open-minded Risk-takers Balanced Ecology assess students to consider how organisms interact with each other and their environment. The natural extension of ecological study for students is for them to consider their own impact on the environment and how their behaviors lead to maintaining a clean, healthful, and sustainable environment now and into the future. Literally every component of the learner profile can be considered around the theme of conservation. A global concern exists for many conservation causes from biodiversity, to access to clean and plentiful water, to clean air, and to development of sustainable forestry and agriculture practices. The history of the environmental movement requires an understanding of the intersection of science, politics and the conservation message. A thorough understanding of the environmental movement and conservation requires

	multiple perspectives. Students can contribute to the conservation effort by involving themselves in community action to restore natural areas, participate in clean-up efforts, or promote —green‖ lifestyles. The benefits to individual mental, spiritual and physical health are manifest in participating in outdoor activities where students have a chance to be immersed in the natural world and to appreciate all the reasons why sustainability through conservation is such an important concept for our future.

7. Useful links

Biology and ethics education project (BEEP):www.beep.ac.uk/content/index.php

Simulations

KScience (www.kscience.co.uk/animations/anim_1.htm)
Explorelearning (www.explorelearning.com)
eduMedia (www.edumedia-sciences.com)
http://www.kscience.co.uk/animations/anim_2.htm.

Virtual dissections

A virtual salmon dissection that allows students to conduct their own dissection, can be found at www.mydoctorgames.com/salmon-dissection/game/.

Virtual eye dissection
www.eschoolonline.com/company/examples/eye/eyedissect.html
The site www.teachkind.org/dissectalt.asp offers a number of ideas for humane dissection alternatives.

Databases

CRCnetBase: www.crcnetbase.com
Intergovernmental panel on climate change (IPCC): www.ipcc.ch
National Oceanographic Data Center (NODC): www.nodc.noaa.gov
1000 Genomes: www.1000genomes.org

Gapminder: www.gapminder.org

Apps for Smartphones

www.nasa.gov/connect/apps.html#.U34C6fldV8E from the National Aeronautics and Space Administration (NASA)
http://sciencenetlinks.com/collections/science-apps from the American Association for the Advancement of Science (AAAS).
It is possible to find some recommended apps by looking at reviews of apps in online sources. See, for example:
www.sellcell.com/blog/five-data-logging-apps-for-schools-and-colleges
blog.laptopmag.com/best-science-apps-iphone, which recommends 10 science apps
www.wired.com/wiredscience/2008/07/20-iphone-apps, which has 22 iPhone science apps.

www.pinterest.com/ntxscied/citizen-science-programs	A pin board list of over 50 Citizen Science Programs
brunalab.org/apps	A comprehensive list of apps for biology
www.whatsinvasive.org	Geotagged photographs
http://www.imapinvasives.org	Online tool for invasive species reporting and data management
www.usanpn.org/nn/mobile-apps	Nature's Notebook iPhone and Android app
www.invasivespeciesinfo.gov/toolkit/monitoringsmart.shtml	The USDA National Agricultural Library has a web page with smartphone applications for invasive species monitoring and identification
play.google.com/store/apps/details?id=com.cosalux.welovestars	For estimating the brightness of the night sky as part of a project on light pollution
ebird.org/content/ebird/news/birdlog	The official app for data entry into the Cornell Lab of Ornithology's bird project
itunes.apple.com/us/app/national-geographics-handheld/id315268465 (National Geographic Birds)	The National Geographic Birds iPhone app provides up-to-date range maps, journal feature, info on more bird species (995) than any other app
www.marinedebris.engr.uga.edu	Log trash on coastlines and waterways (US only)
www.noisetube.net/	Monitors any noise pollution anywhere, but app may be used in labs as it measures sound in decibels
itunes.apple.com/us/app/expedition-white-shark/id488682903	Allows you to follow tagged great white sharks

www.inaturalist.org	Provides a means of recording the geolocation of a species while out in the field and many advanced features for studying invasive and endangered species
www.projectnoah.org/mobile	Project Noah is a tool to explore and document wildlife and a platform to harness the power of citizen scientists everywhere
www.biocourseware.com/iphone/ghistory/	A brief history of genetics: if you need to look up Rosalind Franklin, consider this interactive genetics timeline