Diploma Programme subject outline—Group 4: sciences

School name	Thomas Jefferson High School	**School code**	052227
Name of the DP subject	Biology		
Level *(indicate with X)*	Higher [ ] Standard completed in two years [X] Standard completed in one year * [ ]		
Name of the teacher who completed this outline	Sheridan Gillam	**Date of IB training**	10/12/2017-10/14/2017
Date when outline was completed		**Name of workshop** *(indicate name of subject and workshop category)*	CASIE Category 1 Biology

	Topic/unit (as identified in the IB subject guide)	**Contents**	**Allocated time** O [ ] minutes. I [ ] classes.	**Assessment instruments to be used**	**Resources** *List the main resources to be used, including information technology if applicable*
Year 1	Topic 4: Ecology	**4.1 Species, communities and ecosystems** *Species are groups of organisms that can potentially interbreed to produce fertile offspring. Members of a species may be reproductively isolated .Species have either an autotrophic or heterotrophic method of nutrition (a few species have both methods). Consumers, detritivores, and saprotrophs are heterotrophs.. A community is formed by populations of different species living and interacting. A community forms an ecosystem by its interactions with the abiotic environment. Autotrophs obtain inorganic nutrients from the abiotic environment. The supply of inorganic nutrients is maintained by nutrient cycling. Ecosystems have the potential to be sustainable.*	**SL Year 1** **24 hours: 1440 min: 16 classes** 4.1 Species, communities and ecosystems: 4 classes= 360 min 4.2 Energy flow: 4 classes= 360 min	Students will be doing labs for topics 1.1, 1.4, 2.1, 2.5, 2.8, 2.9, 4.1, 3.5, 5.2, and 6.4. There will be multiple choice questions in formative and summative assessments over all topics. Free response, mathematical reasoning, and graphing	Campbell Biology Textbooks iPads Microsoft Office

		4.2 Energy flow *Ecosystems use light energy to be converted to chemical energy by photosynthesis. Chemical energy in carbon compounds flows through food chains. Energy released from carbon compounds by respiration is used in living organisms and converted to heat. Living organisms cannot convert heat to other energy. Energy losses between trophic levels restrict food change size and biomass between trophic levels.* **4.3 Carbon cycling** *Autotrophs convert carbon dioxide. In aquatic ecosystems carbon is present as dissolved carbon dioxide and hydrogencarbonate ions. Carbon dioxide is produced by respiration. Methane is produced from organic matter in anaerobic conditions by methanogenic archaeans. Methane is oxidized. Peat forms when organic matter is not fully decomposed. Partially decomposed organic matter from past geological eras was converted either into coal, oil or gas that accumulate in porous rocks. Carbon dioxide is made by the combustion of biomass and fossilized organic matter. Some animals such as have hard parts that are composed of calcium carbonate and can become fossilized in limestone.* **4.4 Climate change** *There is a correlation between rising atmospheric concentrations of carbon dioxide since the start of the industrial revolution 200 years ago and average global temperatures. Global temperatures and climate patterns are influenced by concentrations of greenhouse gases.*	4.3 Carbon cycling: 4 classes= 360 min 4.4 Climate change: 4 classes= 360 min	will be used in formative and summative assessments as well.	
	Topic 2: Molecular Biology	**2.1 Molecules to metabolism** *Carbon atoms can form four covalent bonds allowing diversity. Life is based on carbon compounds: carbohydrates, lipids, proteins and nucleic acids. Metabolism is the web of all the enzyme-catalysed reactions in a cell or organism.* **2.2 Water** *Hydrogen bonding and dipolarity explain properties of water. hydrophilic vs hydrophobic*. **2.3 Carbohydrates and lipids** *Understands the monomer and polymers of carbohydrates. Understand lipid structure and the different forms of fats such as unsaturated and saturated.* **2.4 Proteins** *Amino acids are coded for by genes and are put together to make polypeptides.* **2.5 Enzymes** *Enzymes are a catalyst that gives substrates and active site to bind.* **2.6 Structure of DNA and RNA** *DNA and RNA are the polymers of nucleotides. DNA=double helix and is antiparallel.* **2.7 DNA replication, transcription and translation**: *DNA is unwound by DNA Helicase and replicated to synthesize mRNA through RNA polymerase to code for amino acids.*	**Year 1 SL: 42 hr: 2520 min: 28 classes(block)** 2.1 Molecules to metabolism: 4 classes= 360 min 2.2 Water: 2 classes= 180 2.3 Carbohydrates and lipids: 4 classes= 360 min 2.4 Proteins: 4 classes: 360 2.5 Enzymes: 4 classes: 360 min 2.6 Structure of DNA and RNA: 6 classes: 540 min 2.7 DNA replication, transcription and translation: 8 classes: 720 min 2.8 Cell respiration: 4 classes: 360 min		

		2.8 Cell respiration: *Respiration makes generates usable energy. Anaerobic vs Aerobic* **2.9 Photosynthesis**: *Production of carbon compounds using light energy. Light has different wavelengths. Chlorophyll absorbs red and blue and reflects green.*	2.9 Photosynthesis: 4 classes: 360 min		
	Topic 1: Cell Biology	**1.1 Introduction to cells:** *Understands components of cell theory. Surface area to volume ratio is limits cell size. Multicellular organisms have properties from the interaction of their cellular components. Specialized tissues can develop by cell differentiation. Stem cells divide and differentiate for embryonic development and have therapeutic uses.* **1.2 Ultrastructure of cells** *Prokaryotes have a simple cell structure without compartmentalization and Eukaryotes are compartmentalized. Electron microscopes have a higher resolution than light microscopes.* **1.3 Membrane structure** *Phospholipids form bilayers in water. Membrane proteins are diverse. Cholesterol is in animal cell membranes.* **1.4 Membrane transport** *Particles move across membranes by simple diffusion, facilitated diffusion, osmosis and active transport.* **1.5 The origin of cells** *Cells are formed by division of pre-existing cells. The first arose from non-living material. Eukaryotic cell origin is explained by endosymbiotic theory.* **1.6 Cell division** Mitosis is division of the nucleus into two genetically identical daughter nuclei.	**Year 1 SL** **Total Hours 3 Minutes: 1800 Classes: 20 (block schedule)** 1.1 Introduction to cells: 4 classes=360 min 1.2 Ultrastructure of cells: 2 classes 180 minutes 1.3 Membrane structure:4 classes: 360 minutes 1.4 Membrane transport: 4 classes: 360 minutes 1.5 The origin of cells: 2 classes: 180 minutes 1.6 Cell division: 4 classes: 360 minutes		
Year 2	Topic 3: Genetics	**3.1 Genes** *A gene is a heritable factor that consists of a length of DNA and influences a specific characteristic. A gene occupies a specific position on a chromosome. Alleles differ from each other by one or only a few bases. New alleles are formed by mutation. The genome is the whole of the genetic information of an organism. The entire base sequence of human genes was sequenced in the Human Genome Project.* **3.2 Chromosomes** *Prokaryotes have one chromosome consisting of a circular DNA molecule. Some prokaryotes also have plasmids but eukaryotes do not. Eukaryote chromosomes are linear DNA molecules associated with histone proteins. In a eukaryote species there are different chromosomes that carry different genes.* **3.3 Meiosis** *One diploid nucleus divides by meiosis to produce four haploid nuclei. The halving of the chromosome number allows a sexual life cycle with fusion of gametes, which*	**SL Year 2** **30 Hours: 1800 min: 20 classes (block)** 3.1 Genes: 6 classes= 540 min 3.2 Chromosomes: 6 classes= 540 min 3.3 Meiosis: 6 classes= 540 min 3.4 Inheritance: 7 classes= 630 min 3.5 Genetic modification and biotechnology : 5 classes= 450 min		

		causes variation. DNA is replicated before meiosis so that all chromosomes consist of two sister chromatids. The early stages of meiosis involve pairing of homologous chromosomes and crossing over followed by condensation, resulting in variation. **3.4 Inheritance** *Mendel discovered the principles of inheritance with experiments in which large numbers of pea plants were crossed. Dominant alleles mask the effects of recessive alleles but co-dominant alleles have joint effects. Some are due to dominant, co-dominant alleles, or are sex-linked. The pattern of inheritance is different with sex-linked genes due to their location on sex chromosomes. Radiation and mutagenic chemicals increase the mutation rate and can cause genetic diseases and cancer*. **3.5 Genetic modification and biotechnology** *Gel electrophoresis is used to separate proteins or fragments of DNA by size. PCR can be used to amplify small amounts of DNA. DNA profiling is a comparison of DNA. shared by species within a group.*			
	Topic 5: Evolution and Biodiversity	**5.1 Evidence for evolution** *Evolution occurs when heritable characteristics of a species change. The fossil record provides evidence for evolution. Selective breeding of domesticated animals shows that artificial selection can cause evolution. Evolution of homologous structures by adaptive radiation explains similarities in structure when there are differences in function. Populations of a species can gradually diverge into separate species by evolution. Continuous variation across the geographical range of related populations matches the concept of gradual divergence.* **5.2 Natural selection** *Natural selection can only occur if there is variation among members of the same species. Mutation, meiosis and sexual reproduction cause variation between individuals in a species. Adaptations are characteristics that make an individual suited to its environment and way of life. Species tend to produce more offspring than the environment can support. Individuals that are better adapted tend to survive and produce more offspring while the less well adapted tend to die or produce fewer offspring. Individuals that reproduce pass on characteristics to their offspring. Natural selection increases the frequency of characteristics that make individuals better adapted and decreases the frequency of other characteristics leading to changes within the species.* **5.3 Classification of biodiversity** *The binomial system of names for species is universal among biologists and has been agreed and developed at a series of congresses. When species are discovered they are given scientific names using the binomial system. Taxonomists classify species using a hierarchy of taxa. All organisms are classified into three domains. The principal taxa for classifying eukaryotes are kingdom, phylum, class, order, family, genus and species. In a natural classification, the genus and accompanying higher taxa consist of all the species that have evolved from one common ancestral species. Taxonomists*	**SL Year two** **24 hours: 1440 min: 16 classes** 5.1 Evidence for evolution : 4 classes= 360 min 5.2 Natural selection : 4 classes= 360 min 5.3 Classification of biodiversity: 4 classes= 360 min 5.4 Cladistics: 4 classes= 360 min		

		sometimes reclassify groups of species when new evidence shows that a previous taxon contains species that have evolved from different ancestral species. Natural classifications help in identification of species and allow the prediction of characteristics shared by species within a group. **5.4 Cladistics** *A clade is a group of organisms that have evolved from a common ancestor. Evidence for which species are part of a clade can be obtained from the base sequences of a gene or the corresponding amino acid sequence of a protein. Sequence differences accumulate gradually so there is a positive correlation between the number of differences between two species and the time since they diverged from a common ancestor. Traits can be analogous or homologous. Cladograms are tree diagrams that show the most probable sequence of divergence in clades. Evidence from cladistics has shown that classifications of some groups based on structure did not correspond with the evolutionary origins of a group or species.*			
	Topic 6: Human physiology	**6.1 Digestion and absorption** *Contraction of circular and longitudinal muscle of the small intestine mixes the food with enzymes and moves it along the gut. The pancreas secretes enzymes into the lumen of the small intestine. Enzymes digest most macromolecules in food. Villi increase the surface area of epithelium. Villi absorb monomers formed by digestion as well as mineral ions and vitamins. Different methods of membrane transport are needed.* **6.2 The blood system** *Arteries convey blood at high pressure from the ventricles to the tissues of the body. Arteries have muscle cells and elastic fibres in their walls, which assist in maintaining blood pressure between pump cycles. Blood flows through tissues in capillaries. Capillaries have permeable walls that allow exchange of materials between cells in the tissue and the blood in the capillary. Veins collect blood at low pressure from the tissues of the body and return it to the atria of the heart. Valves in veins and the heart ensure circulation of blood by preventing backflow. There is a separate circulation for the lungs. The heart beat is initiated by a group of specialized muscle cells in the right atrium called the sinoatrial node. The sinoatrial node acts as a pacemaker. The sinoatrial node sends out an electrical signal that stimulates contraction as it is propagated through the walls of the atria and then the walls of the ventricles. The heart rate can be increased or decreased by impulses brought to the heart through two nerves from the medulla of the brain. Epinephrine increases the heart rate to prepare for vigorous physical activity*. **6.3 Defence against infectious disease** *The skin and mucous membranes form a primary defence against pathogens that cause infectious disease. Cuts in the skin are sealed by blood clotting. • Clotting factors are released from platelets. The cascade results in the rapid conversion of fibrinogen to fibrin by thrombin. Ingestion of pathogens by phagocytic white blood cells gives non-specific immunity to diseases. Production of antibodies by lymphocytes in*	**SL Year 2** **40 hours: 2400 min: 27 classes** 6.1 Digestion and absorption: 4 classes= 360 min 6.2 The blood system: 4 classes= 360 min 6.3 Defence against infectious disease: 4 classes= 360 min 6.4 Gas exchange: 4 classes= 360 min 6.5 Neurons and synapses: 5 classe= 450 min 6.6 Hormones, homeostasis and reproduction: 6 classes= 540 min		

		response to particular pathogens gives specific immunity. Antibiotics block processes that occur in prokaryotic cells but not in eukaryotic cells. Viruses lack a metabolism and cannot therefore be treated with antibiotics. Some strains of bacteria have evolved with genes that confer resistance to antibiotics and some strains of bacteria have multiple resistance. **6.4 Gas exchange** *Ventilation maintains concentration gradients of oxygen and carbon dioxide between air in alveoli and blood flowing in adjacent capillaries. Type I pneumocytes are extremely thin alveolar cells that are adapted to carry out gas exchange. Type II pneumocytes secrete a solution containing surfactant that creates a moist surface inside the alveoli to prevent the sides of the alveolus adhering to each other by reducing surface tension. Air is carried to the lungs in the trachea and bronchi and then to the alveoli in bronchioles. Muscle contractions cause the pressure changes inside the thorax that force air in and out of the lungs to ventilate them. Different muscles are required for inspiration and expiration.* **6.5 Neurons and synapses** *Neurons transmit electrical impulses. The myelination of nerve fibres allows for saltatory conduction. Neurons pump sodium and potassium ions across their membranes to generate a resting potential.* **6.6 Hormones, homeostasis and reproduction** *A gene on the Y chromosome causes embryonic gonads to develop as testes and secrete testosterone. Testosterone causes pre-natal development of male genitalia and both sperm production and development of male secondary sexual characteristics during puberty. Estrogen and progesterone cause pre-natal development of female reproductive organs and female secondary sexual characteristics during puberty. The menstrual cycle is controlled by negative and positive feedback mechanisms involving ovarian and pituitary hormones.*			

1. 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.

IB Biology is currently the only IB science, so model C will be used. The topics of molecular biology and human physiology will be addressed. The students will have an entire day to work do work on the track area of the school. They will also be given time to present their findings.

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

Name of the topic	Experiment	Any ICT used? *Remember you must use all five within your programme.*
1.1 Introduction to cells	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 ultrastructures shown in drawings or micrographs.	Yes
1.4 Membrane transport	Estimation of osmolarity in tissues by bathing samples I hypotonic and hypertonic solutions.	Yes
2.1 Molecules to metabolism	Students will test different food items for lipids, proteins, starches, and glucose. They will compare the results.	Yes
2.5 Enzymes	Experimental investigation of a factor affecting enzyme activity.	Yes
2.8 Cell respiration	Students will investigate the rate of respiration in different organisms.	Yes
2.9 Photosynthesis	Separation of photosynthetic pigments by chromatograph.	Yes
3.5 Genetic modification and biotechnology	Students will do a gel electrophoresis lab using DNA from different organisms.	Yes
4.1 Species, communities and ecosystems	Setting up sealed mesocosms to try to establish sustainability.	Yes
5.2 Evidence for evolution	Students will do an evolution simulation using iPADS.	Yes
6.4 Gas exchange	Monitoring of ventilation in humans at rest and after mild and vigorous exercise.	Yes

3. Laboratory facilities

The current science classrooms have sinks, outlets, lab tables, safety shower, eyewash station, fire extinguisher, and a fire blanket.

4. Other resources

The school has an iPAD cart for IB, but is going to buy more iPADS for students to use for lab simulations. Laptop carts for DP science will also be provided by IB so students can do data logging and graph plotting. The science classrooms require a proper acid/base disposal unit, new dissection materials, and microscopes. These materials will be paid for by the science budget and used in classrooms for next year.

5. 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.

Topic	Link with TOK (including description of lesson plan)
Topic 1	There is a difference between the living and nonliving environment. How will you be able to know?
Topic 2	Development of some techniques benefits particular human populations more than others. For example, the development of lactose free milk available in Europe and the US would have greater benefit in Africa/Asia where lactose intolerance is more prevalent, The development of techniques requires financial investment. Should knowledge be shared when techniques developed in one part of the world are more applicable in another?
Topic 3	There is a link between sickle cell anaemia and prevalence of malaria. How can we know whether there is a causal link in such cases or simply a correlation?
Topic 4	The precautionary principle is meant to guide decision-making in conditions where a lack of certainty exists. Is certainty ever possible in the natural sciences?

Topic 5	The adoption of a system of binomial nomenclature is largely due to Swedish botanist and physician Carolus Linnaeus (1707–1778). Linnaeus 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 evaluatingethical aspects of knowledge claims?
Topic 6	Our current understanding is that emotions arethe product of activity in the brain rather than the heart. Is knowledge based on science more valid than knowledge based on intuition?

6. International mindedness

Topic	Contribution to the development of international mindedness (including resources you will use)
1.6 Cell Division	The students will look at the progress/use of stem cell research in different regions of the world and compare the policies and practices surrounding this topic in different areas.
2.9 Photosynthesis	Students will investigate farming globally, and see the impact of hydroponics in communities.
3.1 Genes	Students will look at how alleles of humans have similarities and differences based on region.
4.1 Species, Communities, and Ecosystems	Students will look at the placement of dams globally and how it has impacted local ecosystems of different regions.
5.2 Natural Selection	Students will look at the impact of GMO use in different regions. Students will also compare different regions and the uprising of antibiotic resistance.
6.1 Digestion and Absorption	Students will look at the link of disease to diet based in different communities.

7. Development of the IB learner profile

Topic	Contribution to the development of the attribute(s) of the IB learner profile
Topic 1 Cellular Biology	Students will be inquiries during laboratory investigations. During the labs they will be doing data analysis which will require them to be thinkers. After their lab, they will write a lab report making them knowledgeable.
Topic 2 Molecular Biology	Students will be inquiries during the lab investigations. Students will be reflective and write Cornell notes where they will answer essential questions and look back at their notes. Students will also reflect during the discussion section of their lab reports.
Topic 3 Genetics	Students will be open minded when they read articles about topics such as epigenetics and discuss with classmates. Students will present about different genetic disorders which will demonstrate risk taking and knowledge.
Topic 4 Ecology	Students will read articles and do research of how dams affect local ecosystems. They will also investigate urbanization of rural communities and how that affects populations in that area, which will shape a caring student.
Topic 5 Evolution and Biodiversity	Students will be open minded during Socratic seminars and become communicators while they discuss natural selection and speciation.
Topic 6 Human Physiology	Students will be inquiries during laboratory investigations and communicators as they share the knowledge they gained through presentations.