IB Biology HL Course Guide
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Website: Access through our Class Canvas Course

Welcome to Higher Level Biology at ThunderRidge High School. We look forward to the upcoming two years as we explore and expand your knowledge in the biological sciences.

IB HL Biology is a **college preparatory course**. Examinations will be given in May your senior year along with an internal assessment during the senior year. Successful completion of these assessments could provide you with college credit.

The **purpose** of IB Biology is to guide students to use the knowledge and skills obtained in this course for the improvement of the global society. Over the course of two years you will also be required to **demonstrate proficiency** for the IB Science Objectives and Aims.

IB Biology Core Topic Content Objectives may be found HERE→ IB Official Biology Guide 2016
The Core Topics outline the specific Understandings (knowledge), Application and Skills, Theory of Knowledge Connection and International-Mindedness Area of Focus.

IB Biology HL I / HL II Curriculum Overview and Alignment:
The IB Biology HL I and HL II teachers collaborate in order to align the IB curriculum for the optimum sequence and to build from the TRHS lower level sciences. Content details start on **page 5** of this document.

Bio HL I
- **Cell Biology - Topic 1**
- **Biochemistry - Topic 2**
- **Nucleic Acids and Replication - Topic 2/3/7**
- **Heredity - Topic 3/10**
- **Evolution and Classification - Topic 5/10**
- **Ecology - Topic 4**
- **Ecology Option - Option C**

Bio HL II
- **Protein Structure and Synthesis - Topic 2/7**
- **Enzymes and Metabolism - Topic 2/8**
- **Plant Science - Topic 9**
- **Human Anatomy and Physiology - Topic 6/11**
  - **Digestion, Kidney**
  - **Nervous, Muscle Movement**
  - **Gas Exchange and Transport System**
  - **Immunology**
  - **Endocrine**
  - **Human Reproduction**
- **Internal Assessment: Investigative Exploration**

Course Objectives and Aims

Learning activities are developed to provide IB students the opportunity to be active learners and are designed to support the Group 4 (Investigative Sciences) objectives and aims.

The **objectives** and **aims** of IB Biology are to provide students with an international body of knowledge, investigative techniques, instructional communication technology (ICT) skills, and the ability to analyze and synthesize scientific information.

International-mindedness will be a strand through all curricular units. By studying the historical perspective of science knowledge over time and the discovery and innovations of new science, students will be exposed to the collaborative efforts of a global scientific community. Ethics plays a role in scientific decisions. Each global community has their own beliefs concerning moral, ethical, socio economic issues, which have global environmental implications (TOK). By exploring these issues, students will gain an understanding of other people and their perspectives.

IB Assessments

Include the internal and external assessments, following IB rules and protocols. Details can be found on **page 4 and 5** of this document.

Non-IB Assessments

Assessment practices will follow the Balanced Assessment System. Students will be provided with the learning targets of each curricular unit and will monitor their progress through formative, interim and summative assessments. Formative and interim assessments will drive instructional and reinforcement activities. Summative

assessments will consist of unit exams and performance (laboratory and case studies) assessments. All unit exams will follow the IB external exam format.

Group 4 AIMS © International Baccalaureate Organization Biology Guide 2016

Through the study of biology, chemistry or physics, students 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 these subjects.

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.

Learner Profile Application:

In IB Bio HL, students will experience learning opportunities that reinforce the following characteristics.

- *Inquirers*: Develop skills necessary to conduct research and show independent learning
- *Knowledgeable*: Students must acquire the necessary background information before venturing into hypothesis formulation.
- *Risk Takers:* Able to develop creative correlations to scientific information takes an imaginative leap that may not always feel comfortable
- *Balanced*: Students will have to balance the needs of many people in order to propose compromises to case scenario dilemmas
- *Communicators*: Within their research teams, students will acquire the skills to work cooperatively and will effectively communicate their results for peer review, emulating true science in the publication of results in scientific journals and at conferences.
- *Reflective*: Analysing and communicating the outcome of investigations; monitor their own learning and developing remediation plans
- *Principled:* able to present their information accurately and honestly.

Course Delivery

Instructional Approach: Classroom Practices that Support the IB Philosophy

Throughout this course of study, students will perform laboratory investigations, research real world case studies, and use/develop models to understand biology. Below is a description of how each instructional activity supports the IB philosophy.

Laboratory Investigations:
IB Biology is a laboratory-based curriculum, in which students develop, conduct, analyse and conclude numerous investigations and to report findings by way of informal and formal laboratory reports and peer-reviewed presentations. Some investigations will occur outside of the class time. All written work will be submitted through http://www.turnitin.com.

Investigative Teams (Collaboration) will be formed and the students will explore different biological concepts through laboratory investigations. They will propose hypotheses; develop experimental design; conduct the investigations; analyse the results; validate or propose alternative hypotheses to the investigation. Experimental collaboration will occur within each of the research teams. Teams will present their data for peer review, reflecting the true nature of science review.

Case Studies: In science, case studies are stories that explore real life environmental, medical, ethical, and philosophical scenarios with real world application. They require cooperative research, analysis, and a proposal of possible solutions and/or outcomes

The **internal assessment** is based upon students developing and using these skills on an independent research investigation. They will transfer the skills learned cooperatively into an independent research situation.

Group 4 Project: An interdisciplinary research activity that includes all of the Group 4 students. At TRHS, this will include physics, chemistry and biology. IB science students will work collaboratively around one scientific topic.

Use of Models:
Students will need to understand mechanisms of life that are not directly observable. A variety of models are used (mathematical, diagrams, and computer animations) in science to illustrate and explain these different mechanisms (e.g. fluid mosaic plasma membranes, electron transport chains, distribution of populations, photosystems, sarcomeres and cell signalling.)
Students will be asked to understand, explain, and illustrate scientific models. They will also be asked to develop their own models either through illustrations, 3-D, or metaphorically. **International-mindedness** will be a strand through all curricular units. By studying the historical perspective of science knowledge over time and the discovery and innovations of new science, students will be exposed to the collaborative efforts of a global scientific community. Ethics plays a role in scientific decisions. Each global community has their own beliefs concerning moral, ethical, socio economic issues, which have global environmental implications (TOK). By exploring these issues, students will gain an understanding of other people and their perspectives.

TOK Application: Scientific Investigations directly correlate to TOK.

- *Ways of Knowing***:** "Driven by emotion, using sense perception enhanced by technology and combined with reason, it "science" communicates through language, principally the universal language of mathematics." (IB Bio Guidelines 25)
- *Technology*: Experimental investigations will include the use of Computer Based Learning (CBL) technology. Probeware will be used to collect and analyse the data. e.g. pressure sensors, pH sensors, dissolved oxygen, colorimeters.
- *Scientific Method*: There is not one scientific method. Application and discussion of inductive, deductive methods and naturalistic approaches will be used in the implementation of science investigations.
- *Limitations*: Mathematical evaluation will be used to assess the data within the limitations of science. Error analysis will be conducted to explain the limitations of the experimental design and conduction of the investigation.
- *Reason and Knowledge*: What part does emotion play in the acquisition of knowledge? Does the role of emotion vary across the different areas of knowledge?
- Ability to identify *relevant knowledge* embedded in a real-life situation.
- *Global and ethical issues* are discussed in detail. Students will come to understand the cultural differences that lead to different approaches in scientific endeavours.

- *International Open-mindedness* and *Caring*: students will discover the economic and social differences existing in different areas around the world by researching a variety of case studies. In order to propose solutions to these cases, students must be able to look outside of their perceptions and face the reality of what other people experience.
- *Limitations of Knowledge*: Requires an understanding of the limitations of science and technology may be different depending upon the country.
- *Limitations of science and technology*: Requires an understanding of the limits of the information based upon the limits of the technology used. Understands that models change as new information is obtained.

CAS and EE: The IB Core team supports Creativity, Action, and Service and Extended Essay work by serving as CAS and EE sponsors for students.

IB Biology HL Classroom Policies

All students have the right to learn and participate to the best of their abilities. I follow the:

- IB-TRHS Assessment Policy
- IB-TRHS Academic Integrity Policy
- IB-TRHS Language Policy
- IB-TRHS Inclusion Policy.
- IB-TRHS Resolution Policy

Assessment Policy

Students are expected to be active learners. Self-evaluation and creation of learning plans is a requirement of all students. The grade will reflect what a student knows and the skills obtained over the course of the year.

IB Biology HL I Grade Breakdown

50% Proficiencies
30% Investigative work
5% Homework/Responsibility
15% Final Exam

IB Biology HL II Grade Breakdown

60% Proficiencies
30% Investigative Work
10% Homework/Responsibility

Research has shown that students who take IB courses perform better in college regardless of their exam score. Students who perform well in IB Biology can expect to do well on the IB Biology examination given in May of the senior year, and may be eligible to receive college credit for your high school efforts.

Work that is: incomplete or poorly done will be returned as "**Incomplete**", and must be resubmitted for grading. Most written work will be submitted through **turnitin.com** as well as turning in a hard copy.

Course Success

In order to be successful, you must commit the time and effort to acquire the necessary knowledge and skills.

- Develop a study schedule. Studying should be interactive in order to foster learning.
- Attend scheduled study sessions throughout the year.
- Become an active member of a study group. All students are expected to participate.
- Ask for additional assistance when you are struggling.
- Additional Suggestions can be found on my website under IB Documents-Study Tips.

Academic Honesty

The TRHS-IB Academic Honesty Policy will be strictly enforced.
Plagiarism (intentional submission of another person's work,) Collusion (unapproved sharing of work), "cooking" or "trimming" data will NOT be tolerated. Any time another person's ideas, information or data is used, citations will be required to acknowledge these contributions. This applies not only to papers and laboratory reports but also to homework assignments, etc.

Attendance and Behavioural Expectations

When you are absent, you should complete regular assignments during your absence. For an Excused Absence, you will have one school day for each day excused to complete assigned work. YOU are responsible for getting all necessary details and information about your work:

You will need to designate a “Biology Buddy” in this class. Please exchange phone numbers with this individual so that if you are absent, you can contact your “Biology Buddy” to find out what you missed.
All TRHS rules apply. Please refer to the student handbook

IB Assessment Criteria

Internal Assessment (IA) 20% of IB Grade:
The IA is based upon the student’s performance in **laboratory investigations**. Student’s work is judged on a set of identified criteria and not in comparison to other students, using an internal assessment rubric provided by IB. Internal assessment is assessed by the classroom teacher and moderated to IB.

IB Biology Internal Assessment Criteria

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

External Assessment 80% of IB Grade
The external assessments consist of three papers (examinations) in May of your senior year.
Paper 1: (May Exam)

- 60 min
- 20% overall weighting
- 40 multiple-choice questions on the core and AHL material using Objectives 1, 2, and 3.
- No calculators are permitted.

Paper 2: (May Exam)

- 135 min:
- 36% overall weighting (18 % objectives 1 and 2; 18 % Objective 3.)
- Calculators are permitted.
- Data Based Question.
- Short-answer and extended-response questions on the core and AHL material from a choice of two out of three questions. (all compulsory)

Paper 3: (May Exam)

- 75 min:
- 24% overall weighting assessment objectives 1, 2, 3 and 4
- 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. (all compulsory)
- Calculators are permitted.

Curriculum Details

Cell Biology - Topic 1

- 1.1 Introduction to cells
  Essential idea: The evolution of multicellular organisms allowed cell specialization and cell replacement.
- 1.2 Ultrastructure of cells
  Essential idea: Eukaryotes have a much more complex cell structure than prokaryotes.
- 1.3 Membrane structure
  Essential idea: The structure of biological membranes makes them fluid and dynamic.
- 1.4 Membrane transport
  Essential idea: Membranes control the composition of cells by active and passive transport.
- 1.5 The origin of cells
  Essential idea: There is an unbroken chain of life from the first cells on Earth to all cells in organisms alive today.
- 1.6 Cell division
  Essential idea: Cell division is essential but must be controlled.

Theory of knowledge and the Nature of Science in Cell Biology

- Looking for trends and discrepancies - although most organisms conform to cell theory, there are exceptions.
- Ethical implications of research - research involving stem cells is growing in importance and raises ethical issues.
- There is a difference between the living and the nonliving environment. How are we able to know the difference?
- Developments in scientific research follow improvements in apparatus - the invention of electron microscopes led to greater understanding of cell structure.
- The world 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?
- Using models as representations of the real world - there are alternative models of membrane structure.
- Falsification of theories with one theory being superseded by another - evidence falsified the Davson-Danielli model.
- 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?
- Experimental design - accurate quantitative measurement in osmosis experiments are essential.
- Testing the general principles that underlie the natural world - the principle that cells only come from pre-existing cells needs to be verified.
- Biology is the study of life, yet life is an emergent property. Under what circumstances is a systems approach productive in biology and under what circumstances is a reductionist approach more appropriate? How do scientists decide between competing approaches?
- Serendipity and scientific discoveries - the discovery of cyclins was accidental.
- 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?

Biochemistry - Topic 2

- 2.1 Molecules to metabolism
  Essential idea: Living organisms control their composition by a complex web of chemical reactions.
- 2.2 Water
  Essential idea: Water is the medium of life.
- 2.3 Carbohydrates and Lipids
  Essential idea: Compounds of carbon, hydrogen, and oxygen are used to supply and store energy.

Theory of knowledge and the Nature of Science in Biochemistry

- Falsification of theories - the artificial synthesis to falsify vitalism.
- Use of theories to explain natural phenomena - the theory that hydrogen bonds form between water molecules explains the properties of 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?
- Evaluating claims - health claims made about lipids in diets need to be assessed.
- There are conflicting views as to the harms and benefits of fats in diets. How do we decide between competing views?
- Looking for patterns, trends and discrepancies - most but not all organisms assemble proteins from the same amino acids.
- Experimental design - accurate, quantitative measurements in enzyme experiments require replicates to ensure reliability.
- 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.

Nucleic Acids and Replication - Topic 2/3/7

- 2.6 Structure of DNA and RNA
  Essential idea: The structure of DNA allows efficient storage of genetic information.
- 2.7 DNA replication, transcription and translation
  Essential idea: Genetic information in DNA can be accurately copied and can be translated to make the proteins needed by the cell.

- 7.1 DNA structure and replication AHL
  Essential idea: The structure of DNA is ideally suited to its function.

Theory of knowledge and the Nature of Science in DNA and Biotechnology

- Using models as representation of the real world - Crick and Watson used model making to discover the structure of DNA.
- The story of the elucidation of the structure of DNA illustrates that cooperation and collaboration among scientists exists 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 sciences?
- Obtaining evidence for scientific theories - Meselson and Stahl obtained evidence for the semi-conservative replication of DNA.
- 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?
- Making careful observations - Rosalind Franklin's x-ray diffraction provided crucial evidence that DNA is a double helix.
- 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?
- Developments in scientific research follow improvements in computing - the use of computers has enabled scientists to make advances in bioinformatics applications such as locating genes within genomes and identifying conserved sequences.

Heredity - Topic 3/10

- 3.1 Genes
  Essential idea: Every living organism inherits a blueprint for life from its parents.
- 3.2 Chromosomes
  Essential idea: Chromosomes carry genes in a linear sequence that is shared by members of a species.
- 3.3 Meiosis
  Essential idea: Alleles segregate during meiosis allowing new combinations to be formed by the fusion of gametes.
- 3.4 Inheritance
  Essential idea: The inheritance of genes follows patterns.
- 10.1 Meiosis AHL
  Essential idea: Meiosis leads to independent assortment of chromosomes and unique composition of alleles in daughter cells.
- 10.2 Inheritance AHL
  Essential idea: Genes may be linked or unlinked and are inherited accordingly.

Theory of knowledge and the Nature of Science in Heredity

- Developments in scientific research follow improvements in technology - gene sequencers are used for the sequencing of genes.
- Sequencing of the human genome shows that all humans share the vast majority of their base sequences but also that there are many single nucleotide polymorphisms that contribute to human diversity.
- Developments in research follow improvements in techniques - autoradiography was used to establish the length of DNA molecules in chromosomes.
- In 1922 the number of chromosomes counted in a human cell was 48. This remained the established number 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?
- Making quantitative measurements with replicates to ensure reliability. Mendel's genetic crosses with pea plants generated numerical data.
- Mendel's theories were not accepted by the scientific community for a long time. What factors would encourage the acceptance of new ideas by the scientific community?
- Making careful observations - careful observation and record keeping turned up anomalous data that Mendel's law of independent assortment could not account for. Thomas Hunt Morgan developed the notion of linked genes to account for the anomalies.
- Looking for patterns, trends and discrepancies - Mendel used observations of the natural world to find and explain patterns and trends. Since then, scientists have looked for discrepancies and asked questions

based on further observation to show exception to the rules. For example, Morgan discovered non-Mendelian ratios in his experiments with Drosophila.
- 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?

Evolution and Classification - Topic 5/10
- 5.1 Evidence for evolution
  Essential idea: There is overwhelming evidence for the evolution of life on Earth
- 5.2 Natural Selection
  Essential idea: The diversity of life has evolved and continues to evolve by natural selection.
- 5.3 Classification of biodiversity
  Essential idea: Species are named and classified using an internationally agreed system.
- 5.4 Cladistics
  Essential idea: The ancestry of groups of species can be deduced by comparing their base or amino acid sequences.
- 10.3 Gene pools and speciation
  Essential idea: Gene pools change over time.

Theory of knowledge and the Nature of Science in Evolution and Classification
- Looking for patterns, trends, and discrepancies - there are common features in the bone structure of vertebrate limbs despite their varied use.
- 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 cases. How do these methods compare to those used by historians to reconstruct the past?
- Use theories to explain natural phenomena - the theory of evolution by natural can explain the development of antibiotic resistance in bacteria.
- Natural selection is a theory. How much evidence is required to support a theory and what sort of counter evidence is required to refute it?
- Cooperation and collaboration between groups of scientists - scientists use the binomial system to identify a species rather than the many different local names.
- The adoption of a system of binomial nomenclature is largely due to Swedish botanist and physician Carolus Linnaeus. 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 evaluating ethical aspects of knowledge claims?
- Falsification of theories with one theory being superseded by another - plant families have been classified as a result of evidence from cladistics.
- A major step forward in the study of bacteria was the recognition in 1977 by Carl Woese that Archaea have a separate line of evolutionary descent from bacteria. Famous scientists, including Luria and Mayr, objected to his division of the prokaryotes. To what extent is conservatism in science desirable?
- Looking for patterns, trends, and discrepancies - patterns of chromosomes number in some genera can be explained by speciation due to polyploidy.
- 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 successes?

Ecology - Topic 4
- 4.1 Species, communities, and ecosystems
  Essential idea: The continued survival of living organisms including humans depends on sustainable communities.
- 4.2 Energy flow
  Essential idea: Ecosystems require a continuous supply of energy to fuel life processes and to replace energy lost as heat.
- 4.3 Carbon cycle
  Essential idea: Continued availability of carbon in ecosystems depends on carbon cycling.
- 4.4 Climate change

Essential idea: Concentrations of gases in the atmosphere affect climates experience at the Earth's surface.

Theory of knowledge and the Nature of Science in Ecology

- Looking for patterns, trends, and discrepancies - plants and algae are mostly autotrophic but some are not.
- Use theories to explain natural phenomena - the concept of energy flow explains the limited length of food chains.
- Making accurate, quantitative measurements - it is important to obtain reliable data on the concentration of carbon dioxide and methane in the atmosphere.
- Assessing claims - assessment of the claims that human activities are producing climate change.
- 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?

Ecology - Option C

- C.1 Species and Communities
  Essential idea: Community structure is an emergent property of an ecosystem.
- C.2 Communities and Ecosystems
  Essential idea: Changes in community structure affect and are affected by organisms.
- C.3 Impacts of Humans
  Essential idea: Human activities impact on ecosystem function.
- C.4 Conservation of Biodiversity
  Essential idea: Entire communities need to be conserved in order to preserve biodiversity.
- C.5 Population Ecology
  Essential idea: Dynamic biological processes impact population density and population growth.
- C.6 Nitrogen and Phosphorus cycles
  Essential idea: Soil cycles are subject to disruption.

Theory of knowledge and the Nature of Science in Ecology Option

- Use models as representations of the real world—zones of stress and limits of tolerance graphs are models of the real world that have predictive power and explain community structure.
- Random samples are taken in studies involving large geographical areas or if limited time is available. Is random sampling a useful tool for scientists despite the potential for sampling bias?
- Use models as representations of the real world - pyramids of energy model the energy flow through ecosystems
- Do the entities in scientists' models, for example trophic levels or Gersmehl diagrams, actually exist, or are they primarily useful inventions for predicting and explaining the natural world?
- Assessing risks and benefits associated with scientific research - the use of biological control has associated risks and requires verification by tightly controlled experiments before it is approved.
- Scientists collaborate with other agencies - the preservation of species involves international cooperation through intergovernmental and non-governmental organizations.
- Avoiding bias - a random number generator helps to ensure population sampling is free from bias.
- Assessing risks and benefits of scientific research - agricultural practices can disrupt the phosphorus cycle.

Protein Structure and Synthesis - Topic 2/7

- 2.4 Proteins
  Essential idea: Proteins have a very wide range of functions in living organisms.
- 2.7 DNA replication, transcription and translation
  Essential idea: Genetic information in DNA can be accurately copied and can be translated to make the proteins needed by the cell.
- 3.5 Genetic modification and biotechnology
  Essential idea: Biologists have developed techniques for artificial manipulation of DNA, cells, and organisms.
- 7.2 Transcription and gene expression AHL
  Essential idea: Information stored as a code in DNA is copied into mRNA.
- 7.3 Translation AHL
  Essential idea: Information transferred from DNA to mRNA is translated into an amino acid sequence.

Theory of knowledge and the Nature of Science in Protein Structure and Synthesis

- Assessing risks associated with scientific research - scientists attempt to assess the risks associated with genetically modified crops or livestock.
- Looking for patterns, trends and discrepancies - there is mounting evidence that the environment can trigger heritable changes in epigenetic factors.
- 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?

Enzymes and Metabolism - Topic 2/8

- 2.5 Enzymes
  Essential idea: Enzymes control the metabolism of the cell.
- 2.8 Cell Respiration
  Essential idea: Cell respiration supplies energy for the functions of life.
- 2.9 Photosynthesis
  Essential idea: Photosynthesis uses the energy in sunlight to produce the chemical energy needed for life.
- 8.1 Metabolism AHL
  Essential idea: Metabolic reactions are regulated in response to the cell's needs.
- 8.2 Cell Respiration AHL
  Essential idea: Energy is converted to a usable form in cell respiration.
- 8.3 Photosynthesis AHL
  Essential idea: Light energy is converted into chemical energy.

Theory of knowledge and the Nature of Science in Enzymes and Metabolism

- Assessing the ethics of scientific research - the use of invertebrates in respirometer experiments has ethical implications.
- Experimental design - controlling relevant variables in photosynthesis experiments is essential.
- Developments in scientific research follow improvements in computing - developments in bioinformatics, such as the interrogation of databases, have facilitated research into metabolic pathways.
- Many metabolic pathways have been described following a series of carefully controlled and repeated experiments. To what degree can looking at component parts give us knowledge of the whole?
- Paradigm shift - the chemiosmotic theory led to a paradigm shift in the field of bioenergetics.
- Peter Mitchell's chemiosmotic theory encountered years 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?
- Developments in scientific research follow improvements in apparatus - sources of 14C and autoradiography enabled Calvin to elucidate the pathways of carbon fixation.
- 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 a work of art?

Plant Science Topic 9

- 9.1 Transport in the xylem of plants
  Essential idea: Structure and function are correlated in the xylem of plants.
- 9.2 Transport in the phloem of plants
  Essential idea: Structure and function are correlated in the phloem of plants.
- 9.3 Growth in plants
  Essential idea: Plants adapt their growth to environmental conditions
- 9.4 Reproduction in plants
  Essential idea: Reproduction in flowering plants is influenced by the biotic and abiotic environment.

Theory of knowledge and the Nature of Science in Plant Science

- Plants communicate chemically both internally and externally. To what extent can plants be said to have language
- Paradigm shift—more than 85% of the world's 250,000 species of flowering plant depend on pollinators for reproduction. This knowledge has led to protecting entire ecosystems rather than individual species. (2.3)
- Developments in scientific research follow improvements in analysis and deduction—improvements in analytical techniques allowing the detection of trace amounts of substances has led to advances in the understanding of plant hormones and their effect on gene expression. (1.8)

Human Anatomy and Physiology 6/11

Digestion, Kidney

- 6.1 Digestion and absorption
  Essential idea: The structure of the wall of the small intestine allows it to move, digest and absorb food.
- 11.3 The kidney and osmoregulation
  Essential idea: All animals excrete nitrogenous waste products and some animals also balance water and solute concentrations.

Nervous, Muscle Movement

- 6.5 Neurons and synapses
  Essential idea: Neurons transmit the message, synapses modulate the message.
- 11.2 Movement
  Essential idea: The roles of the musculoskeletal system are movement, support and protection.

Gas Exchange and Transport System

- 6.2 The blood system
  Essential idea: The blood system continuously transports substances to cells and simultaneously collects waste products
- 6.4 Gas exchange
  Essential idea: The lungs are actively ventilated to ensure that gas exchange can occur passively.

Immunology

- 6.3 Defence against infectious disease
  Essential idea: The human body has structures and processes that resist the continuous threat of invasion by pathogens.
- 11.1 Antibody production and vaccination
  Essential idea: Immunity is based on recognition of self and destruction of foreign material.

Human Reproduction and Homeostasis (endocrine)

- 6.6 Hormones, homeostasis and reproduction
  Essential idea: Hormones are used when signals need to be widely distributed.
- 11.4 Sexual reproduction
  Essential idea: Sexual reproduction involves the development and fusion of haploid gametes.

Theory of knowledge and the Nature of Science in Human Physiology

- Our current 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?
- Theories are regarded as uncertain—William Harvey overturned theories developed by the ancient Greek philosopher Galen on movement of blood in the body.
- Risks associated with scientific research—Florey and Chain's tests on the safety of penicillin would not be compliant with current protocol on testing. (4.8)
- Developments in scientific research follow improvements in apparatus—William Harvey was hampered in his observational research into reproduction by lack of equipment. The microscope was invented 17 years after his death.
- Consider ethical implications of research—Jenner tested his vaccine for smallpox on a child.
- Assessing risks and benefits associated with scientific research—the risks to human male fertility were not adequately assessed before steroids related to progesterone and estrogen were released into the environment as a result of the use of the female contraceptive pill.
- Disputes over the responsibility for frozen human embryos
- Some sports, such as high-altitude mountain climbing or scuba diving, may push the limits of the human body beyond endurance and cause damage. Should they be controlled or banned?

International-mindedness Application in Human Physiology:

- The Vitamin and Mineral Nutrition Information System (VMNIS), formerly known as the Micronutrient Deficiency Information System (MDIS), was established in 1991 following a request by the World Health Assembly to strengthen surveillance of micronutrient deficiencies at the global level.
- Obtain evidence for theories developed around the world—epidemiological studies have contributed to our understanding of the causes of lung cancer.

- There are numerous drugs that can enhance performance. Is the use of these drugs acceptable in terms of conducting a fair test as long as all athletes have equal access to them? Do all countries follow the same rules of competition?
- The spread and containment of diseases such as bird flu or Ebola require international coordination and communication.
- Cooperation and collaboration between groups of scientists—biologists are contributing to research into memory and learning.
- The World Health Organization initiated the campaign for the global eradication of smallpox in 1967. The campaign was deemed a success in 1977, only 10 years later.
- Cooperation and collaboration between groups of scientists—the International Council for the Control of Iodine Deficiency Disorders includes a number of scientists who work to eliminate the harm done by iodine deficiency.

Resources

Sources:

- IB Biology Guide
  https://ibpublishing.ibo.org/server2/rest/app/tsm.xql?doc=d_4_biolo_gui_1402_2_e&part=1&chapter=1&IBVal=5PCXPF4BZJEZCHE0WGF1&CFID=830281&CFTOKEN=18611943&jsessionid=bc3048f4e7d77a3f74004a747e3f43225e75
- Science: http://www.sciencedaily.com/index.htm
- Nature: http://www.nature.com/index.html
- Scientific American: http://www.sciam.com/
- Science Daily: http://www.sciencedaily.com/index.htm
- New Scientist: http://www.newscientist.com/home.ns
- Science News: http://www.sciencenews.org/

Online Learning Activities:

- Campbell Biology Gate Way (Biology 7/E): www.phschool.com/science/biology_place/
- The Biology Place: online labs www.phschool.com/science/biology_place/
- Biology Project (University of Arizona): http://www.biology.arizona.edu/
- McGraw Hill Online Biology: http://www.biocourse.com/mhhe/bcc
- Plants-In-Motion Created for nonprofit educational use by Roger P. Hangarter Indiana University, Department of Biology, 915 E 3rd St, Bloomington, IN 47405
  http://plantsinmotion.bio.indiana.edu/plantmotion/movements/tropism/tropisms.html
- Genetic Science Learning Center: University of Utah
  http://learn.genetics.utah.edu/units/addiction/index.cfm
- Virtual Fly:
  http://www.sciencecourseware.org/vcise/
- Girls Can't Catch
- http://en.wikibooks.org/wiki/IB_Biology_Practical_Investigations/Statistics/Mythbusting:_%27Girls_can%27t_catch%27
- ICT In Biology: http://www.saburchill.com/IBbiology/ICT/index.html

Databases/Websites

- ICT In Biology: http://www.saburchill.com/IBbiology/ICT/index.html
- EBSCOHost-Approximatley 1900 online science journals.
- eLibrary-approximately 35 online science journals
- ThunderRidge High School is wireless school-wide. Teachers have access to wireless computer carts allowing students to access the resources.
- http://occ.ibo.org
- http://phet.colorado.edu/new/index.php

Software

- Graphical Analysis, Vernier Scientific.
- Microsoft Office, Microsoft Corporation