

Science Education Section  
Biology and Combined Science (Biology)  
Annotated Case I

## 1. Aims

The case below aims to illustrate the following practices of implementing the Biology and Combined Science (Biology) curricula in a secondary school.

- The design of the three-year school-based curriculum plan, and its implications for curriculum planning
- The strategies adopted by the school in implementing assessment for learning
- The strategies adopted by the school in catering for learner diversity

## 2. School Background

- An aided catholic secondary school in Kowloon.
- A girl school with students of average and above average ability.
- Class Structure:

	S1	S2	S3	S4	S5	S6	S7
No. of classes in 2009 -2010	5	5	5	5	5	2	2
No. of classes in 2010 -2011	5	5	5	5	5	2	2
No. of classes in 2011 -2012	5	5	5	5	5	5	2

- Subjects offered in the Science Education KLA in 2009-2010 and 2010-2011 school years:  
S1-2: Science  
S3: Biology, Chemistry, Physics  
S4-5: NSS Biology, Chemistry, Physics, Combined Science (Biology, Chemistry)  
S6-7: Biology, Chemistry, Physics
- Medium of instruction for science subjects in 2010-2011 school year:  
S1: Mainly English  
S2-3: Mainly Chinese  
S4-7: Mainly English
- Lesson time for NSS elective subjects in 2009-2010 and 2010-2011 school years:  
Five 40-minute periods per 6-day cycle

### 3. Curriculum Planning

- Major considerations in devising the 3-year (2009-2012) curriculum plans for NSS Biology and Combined Science (Biology)
  - Students' cognitive development and knowledge building sequence
  - The interest, ability, readiness and maturity of students
  - The difficulty of the topics
  - The prerequisite knowledge and skills needed for the topics
  - The relationship between topics
  - Chapter arrangement of the selected textbook
  - Time and resources available
  - Requirements of School-based Assessment (SBA)

Reflective question:

What are your key considerations in planning the 3-year curriculum for Biology / Combined Science (Biology)?

- Curriculum planning strategies adopted by the school
  - Organising the learning and teaching sequence from foundation topics to integrated topics and advanced / extended topics
  - Spiral arrangement of learning contents
  - Integration of related topics
  - Linking major concepts within the curriculum
  - Applying the curriculum emphases across the curriculum
  - Alignment of knowledge and skills learnt in other subjects e.g. Chemistry

Reflective questions:

What are your strategies of curriculum planning? Do you make reference to the curriculum planning strategies recommended in the *Biology Curriculum and Assessment Guide (S4-6)* (CDC & HKEAA, 2007)?

- Contextual factors
  - Students are willing to learn and well disciplined.
  - In 2010-2011 school year, there are one Biology class and one Combined Science (Biology, Chemistry) class at each S4 and S5 level. Each class has a maximum of 30 students and most students study 2 science subjects.
  - Students studying Biology and Combined Science (Biology) have diverse subject combinations. They are varied in their academic background, numeracy skills, scientific process skills and ability to comprehend abstract concept.
  - Teachers of the science education KLA are aware of the need of holistic curriculum development to ensure smooth transition between junior and senior secondary science education.
  - The biology teachers are very experienced and demonstrate good

understanding of the curriculum. They are also familiar with the available learning and teaching resources including textbooks and resources developed by the EDB.

Reflective question:

When planning your school-based curriculum, do you take into account the characteristics of your students and school contextual factors?

- The 3-year (2009-2012) Biology curriculum plan (Appendix 1)
- The 3-year (2009-2012) Combined Science (Biology) curriculum plan (Appendix 2)
- Implications and recommendations
  - ***Devising a comprehensive and flexible curriculum and assessment plan*** (Refer to Appendix 1 and Appendix 2)  
A variety of learning and teaching activities including practical activities and scientific investigations, as well as relevant learning and teaching resources were included in the curriculum plan to provide a comprehensive reference for planning the lessons. Teachers were flexible in their choice of learning, teaching and assessment activities to maximise the learning of students.
  - ***Focusing on foundation topics at S4 to equip students with fundamental biological knowledge and skills for studying the Biology curriculum at S5 and S6*** (Refer to p.1 & p.3 of Appendix 1)  
At S4, only foundation topics were covered to help students build up a solid foundation in biology. Demanding and abstract topics (e.g. *Ie Cellular energetics: Photosynthesis and Respiration*) were skipped at S4 and were introduced at S5. The teacher found that students were better equipped and more ready to learn the difficult topics at S5 than at S4.
  - ***Spiral arrangement of learning contents for students to revise and consolidate the knowledge and concepts progressively*** (Refer to Appendix 1 and Appendix 2)  
For example, the knowledge of the building block molecules and functions of nucleic acids learned at S4 was consolidated and strengthened when studying molecular genetics at S5; and the basic concepts learned in topic *IIIb Essential life processes in animals* at S4 were revisited when studying topic *IIIe Homeostasis* at S5. For Biology students, they would need to integrate the knowledge and concepts learned in topics *IIIb Essential life processes in animals* and *IIIe Homeostasis* to understand the biological concepts in topic *V Human Physiology: Regulation and Control* at S6
  - ***Linking major concepts within the curriculum by integration of related topics*** (Refer to p.2 of Appendix 1 and Appendix 2)  
Related topics (e.g. *I(d) Cell cycles and division* and *III (c) Reproduction, growth and development*) were introduced together. It would facilitate

students to understand the relationship between major concepts and to study individual topics as integral part of the whole curriculum and not as separate entities.

Besides, practical activities and scientific investigation were integrated into the learning and teaching of principles and concepts, so that students could associate the findings of the experiments with the theories they had learned.

- ***Applying the curriculum emphases across the curriculum*** (Refer to “Learning & Teaching Activities / Learning and Teaching Resources” and “Remarks” of Appendix 1 and Appendix 2)

The three curriculum emphases, Scientific Inquiry, STSE Connections, and Nature and History of Biology (NHB) were covered systematically and extensively throughout the curriculum by matching major content areas with the relevant curriculum emphases. Through applying the curriculum emphases across the curriculum, students would find the learning of biology interesting, exciting and relevant. The teacher had also made good use of the learning and teaching materials in the resource packages provided by EDB.

*Reflective questions:*

How do you plan your learning and teaching sequence? Does the sequence suit your students, your approaches to learning and teaching, and your school context? What would you like to improve in curriculum planning?

#### **4. Learning, Teaching and Assessment**

➤ Assessment for learning – Strategies and implications

- ***Effective planning to ensure understanding of the assessment requirements*** (Refer to “Practical Activities / Scientific Investigations” of Appendix 1 and Appendix 2)

A wide range of practical activities and scientific investigations were included in the curriculum plan to prepare students for conducting the practical-related tasks of SBA progressively. Students were arranged to conduct various practical activities and investigations. Throughout the process, they received timely and constructive feedback from the teacher and became familiar with the assessment criteria for different types of practical-related tasks. In this regard, students would understand how their SBA tasks would be assessed and how they would be helped to make improvement.

- ***Fostering learning motivation by emphasising progress and achievement***  
At S4, most questions (about 60%) selected for assignments, tests or examinations were factual and straight forward. There were also some questions (about 30%) requiring students to apply knowledge to familiar situations. The aim was to facilitate the consolidation of fundamental knowledge and concepts in students, as well as to develop their confidence in learning. As a result, the teacher found that students were motivated and prepared to answer high-order questions. Therefore, the questions for

assignments and examinations at S5 were in general more demanding. There were questions (about 40%) requiring students to make compare and contrast, to explain phenomenon, to analyse data and to apply knowledge to unfamiliar situations. Given the foundation and a sense of achievement built up at S4, students were able to achieve their best and performed well in the first examination at S5. (Refer to Appendix 4)

- ***Promoting understanding of assessment criteria and developing the capacity for self-assessment*** (Refer to Appendix 3)

At S5, the teacher planned to develop students' communication skills in writing short essay. Before asking students to write short essay, the criteria of mark award for communication in essay questions were introduced and discussed. Students were asked to write the first essay on the structural adaptation of a leaf to photosynthesis. After marking students' essays, the teacher picked some good examples to illustrate how the criteria could be met in practice. It aimed to provide students with constructive guidance about how to improve and to engage them in self-assessment. Students were then asked to write another short essay to compare a malignant tumour from a benign one with reference to the marking criteria and the good examples. In this regard, students were provided with opportunities to engage in self-reflection and to identify the steps for making improvement.

*Reflective questions:*

What are your strategies for implementing assessment for learning? How do you communicate the assessment goals and criteria to students? How do you plan to collect evidence about student learning with a view to provide feedback on their performance? How does the feedback on performance provided to students help them to improve?

➤ Catering for learner diversity – Strategies and implications

- ***Arranging learning tasks for students with different abilities*** (Refer to “Practical Activities / Scientific Investigations” of Appendix 1/Appendix 2)  
A wide range of practical activities and scientific investigations varied in scale and demand were included in the curriculum plan to cater for students with different abilities. Besides, the teacher would vary the degree of support, guidance and challenge to students in accordance with their ability.
- ***Adapting the depth of treatment of demanding topics***  
In topic Ia Molecules of life, the details of molecular structures and chemistry processes were skipped to avoid overloading students with a lot of chemical formulas, equations and reactions. This simpler treatment helped those students with limited chemistry knowledge master the basic knowledge of biomolecules at S4. Similar treatment was adopted when introducing the biochemical pathways of photosynthesis and respiration at S5. The overall pathway of each process was outlined instead of breaking down into small steps of biochemical reactions. The biology phenomena and concepts were introduced in a simpler and clearer manner without explaining the details of chemistry. Factual and straight forward questions

were followed to help students consolidate the learning of concepts. For able students, extra support and guidance were provided to help them master the details of molecular structures of biomolecules and biochemical processes of photosynthesis and respiration.

- ***Learning outside classroom in the form of science competitions***  
Students in particular those taking Combined Science (Biology) were arranged to participate in the Hong Kong Students Science Project Competition. It would enhance their exposure to the science community and to develop their knowledge and skills in biology by engaging them in conducting biology-related scientific investigations. At the same time, the teacher could vary the degree of support, guidance and challenge to cater for the diverse capabilities of students.

*Reflective questions:*

What measures do you adopt to cater for learner diversity? How do you design the learning tasks to allow students to progress at their own pace? What strategies do you employ to stretch the potential of students and engage them in learning?

## **5. Impacts on Student Learning**

- Students find the learning of biology interesting and relevant.
- Students master the fundamental knowledge and skills learned at S4 well. They seek to understand difficult and complex subject matter with confidence at S5. Furthermore, they are able to integrate and transfer what they have learned to new situations.
- Students performed better and improved significantly in the first examination at S5, although the examination questions were more demanding than those at S4. According to the statistics of biology examinations, the passing percentage at S5 is significantly higher than that at S4. Besides, similar trend is observed in the credit percentage. (Refer to Appendix 4)

## Biology Curriculum Plan (2009-2012)

Form	Compulsory / Elective Part	Topics	Practical Activities / Scientific Investigations	Learning & Teaching Activities / Learning & Teaching Resources
S4	I. Cells and Molecules of Life	<p><i>Ia Molecules of life</i></p> <p><i>Ib Cellular organization</i></p> <p><i>Ic Movement of substances across membrane</i></p> <p><i>Ie Cellular energetics</i> <i>Metabolism: catabolism and anabolism</i> <i>Enzymes and enzymatic reaction</i></p>	<p>Performing tests for the presence of biomolecules in living tissues</p> <p>Observation with a light microscope Preparation of temporary mounts Examination of prokaryotic and eukaryotic cells Biological drawing (White blood cell &amp; Hydrilla)</p> <p>Demonstration of osmosis using dialysis tubing Study of osmosis in living plant tissue <b>Investigative Lab : Cell Designer</b> Demonstration of the breaking-down action of enzymes Investigation of the effect of temperature / pH / inhibitors on enzyme activity <b>Investigative Lab : An Investigation with Catalase</b> Investigation of protease activities in different fruit juices Design an investigation of the effectiveness of different biological washing powders</p>	<p>Making a fluid mosaic model of cell membrane</p> <p>3D Animation: Osmosis of Cell Membrane</p> <p><b>NHB : The effect of temperature on catalase activity (R1)</b></p>
	III. Organisms and Environment	<p><i>IIIb Essential life processes in animals</i></p>	<p>Detection of food substances by food tests Investigation of food substances present in common foodstuffs <b>Investigative Lab : Vitamin C-A strong antioxidant</b> Dissection of rat to examine the mammalian alimentary canal and its associated glands Design an investigation of the action of digestive enzymes Investigation of the effect of bile salts on oil Examination of the mammalian breathing system / the pig lungs <b>Investigative lab : Fish Breathing</b> Examination of a blood smear / transverse sections of an artery and a vein / capillary flow in a fish tail fin Dissection and examination of a pig heart</p>	<p>Calculations of nutrient requirement NHB : Vitamin Deficiency</p> <p>Examination of the human torso</p>

S4	III. Organisms and Environment	<i>IIIa Essential life processes in plants</i>	Investigation of the effect of light intensity on gas exchange in plants Demonstration of the occurrence of transpiration Measurement of the rate of transpiration using a bubble potometer Design an investigation of the effects of environmental factors on the rate of transpiration Examination of the vascular tissues of a young dicotyledonous plant Investigation of the plant tissue responsible for water transport Investigation of the need for chlorophyll/ carbon dioxide in photosynthesis Design an investigation of the need for light in photosynthesis Examination of the structures of leaves/ chloroplasts Investigation of the effect of light intensity on the rate of photosynthesis Design an investigation of the effect of carbon dioxide concentration on the rate of photosynthesis Examination of meiotic cell division	<b>NHB : The relationship between stomatal distribution and the habitats in flowering plants (R1)</b> Computer Simulation : Design an Investigation of the Effects of Environmental Factors on the Rate of Transpiration  Video : Vascular Tissue of Plant
	I. Cells and Molecules of Life	<i>Id Cell cycle and division</i>		<b>NHB : The relative time spent in each stage of the cell cycle (R1)</b> Animation : Cell Cycle and Mitotic Cell Cycle Video : Investigation of Relative Time Spent in Each Stage of Cell Cycle
	III. Organisms and Environment	<i>IIIc Reproduction, growth and development</i>	Examination and cultivation of a vegetative propagating organ Dissection and examination of a flower Examination of different stages of foetal development	Foetal models <b>PBL : Infertility (R3)</b> <b>STSE : Contraception (R2)</b>

S5	III. Organisms and Environment	III d	Coordination and response	Examination of a human eye model Investigation of the phototropic responses of shoots and roots Examination of a human ear model Examination of a human brain model Electrical Stimulation of a Frog's Leg Observation of the contraction of teased muscle from the leg of a pithed frog Examination of a human arm model	NHB : Irritability in Plant <b>PBL : Bean Sprouts (R3)</b> Knee joint model Elbow joint model Video : Contraction of a Frog's Leg Muscle 3D Animation : Initiation of Muscle Contraction by Nerve Impulses NHB : Insulin Discovery
	II. Genetics and Evolution	III e	Homeostasis		
		II c	Biodiversity and evolution Diversity of life forms Classification of organisms	Using a key to identify organisms from a local Habitat Constructing a dichotomous key for leaves	
	III. Organisms and Environment	III f	Ecosystems	Ecological study of a local habitat	<b>NHB : Predator-prey relationship (R1)</b> <b>STSE : Action Blue Sky (R2)</b>
	I. Cells and Molecules of Life	I e	Cellular energetic Photosynthesis Respiration	Investigation of the need for chlorophyll / carbon dioxide / light in photosynthesis Examination of the structures of leaves / chloroplasts Design an investigation of the effect of light intensity / carbon dioxide concentration on the rate of photosynthesis Examination of the structure of mitochondria Investigation of carbon dioxide/ heat production in a living mouse / germinating seeds Demonstration of anaerobic respiration in germinating seeds <b>Investigative Lab : Yeast Fermentation</b>	
IV. Health and Diseases	IV a	Personal health			
	IV b	Diseases	Ethanol effect on <i>Artemia</i> heart rate Identifying features of mammalian skin that are related to body defence	PBL : Food Poisoning Detective <b>STSE : Infectious Diseases (R2)</b> <b>PBL : Tetanus (R3)</b>	
	IV c	Body defence mechanisms	<b>SBA 1: Amount of antioxidants from different tea samples</b>	<b>NHB : The quest for the first vaccine (R1)</b>	
			<b>SBA 2: Amount of catalase in plant specimen</b>		



## Combined Science (Biology) Curriculum Plan (2009-2012)

Form	Compulsory / Elective Part	Topics	Practical Activities / Scientific Investigations	Learning & Teaching Activities / Learning & Teaching Resources
S4	I. Cells and Molecules of Life	<p><i>Ia Molecules of life</i></p> <p><i>Ib Cellular organisation</i></p> <p><i>Ic Movement of substances across membrane</i></p> <p><i>Ie Cellular energetics</i>  <i>Metabolism: catabolism and anabolism</i>  <i>Enzymes and enzymatic reaction</i></p>	<p>Performing tests for the presence of biomolecules in living tissues</p> <p>Observation with a light microscope            Preparation of temporary mounts            Examination of prokaryotic and eukaryotic cells            Biological drawing (White blood cell &amp; Hydrilla)</p> <p>Demonstration of osmosis using dialysis tubing            Study of osmosis in living plant tissue</p> <p><b>Investigative Lab : Cell Designer</b>            Demonstration of the breaking-down action of enzymes            Investigation of the effect of temperature / pH / inhibitors on enzyme activity</p> <p><b>Investigative Lab : An Investigation with Catalase</b>            Investigation of protease activities in different fruit juices            Design an investigation of the effectiveness of different biological washing powders</p>	<p>Making a fluid mosaic model of cell membrane            3D Animation: Osmosis on Cell Membrane</p> <p><b>NHB : The effect of temperature on catalase activity (R1)</b></p>
	III. Organisms and Environment	<p><i>IIIb Essential life processes in animals</i></p>	<p>Detection of food substances by food tests            Investigation of food substances present in common foodstuffs</p> <p><b>Investigative Lab : Vitamin C-A strong antioxidant</b>            Dissection of rat to examine the mammalian alimentary canal and its associated glands            Design an investigation of the action of digestive enzymes            Investigation of the effect of bile salts on oil            Examination of the mammalian breathing system / the pig lungs</p> <p><b>Investigative lab : Fish Breathing</b></p>	<p>Calculations of nutrients requirements            NHB : Vitamin Deficiency</p> <p>Examination of a human torso</p>

S5	III. Organisms and Environment	<i>IIIb Essential life processes in animals</i>	Examination of a blood smear / transverse sections of an artery and a vein / capillary flow in a fish tail fin Dissection and examination of a pig heart	
		<i>IIIa Essential life processes in plants</i>	Investigation of the effect of light intensity on gas exchange in plants using a data logger Demonstration of the occurrence of transpiration Measurement of the rate of transpiration using a bubble potometer Design an investigation of the effects of environmental factors on the rate of transpiration Examination of the vascular tissues of a young dicotyledonous plant Investigation of the plant tissue responsible for water transport	<b>NHB : The relationship between stomatal distribution and the habitats in flowering plants (R1)</b> Computer Simulation : Design an Investigation of the Effects of Environmental Factors on the Rate of Transpiration  Video : Vascular Tissue of Plant
	I. Cells and Molecules of Life	<i>Id Cell cycle and division</i>	Examination of meiotic cell division	<b>NHB : The relative time spent in each stage of the cell cycle (R1)</b> Animation : Cell Cycle and Mitotic Cell Cycle Video : Investigation of Relative Time Spent in Each Stage of Cell Cycle
		<i>IIIc Reproduction, growth and development</i>	Examination of different stages of foetal development	Foetal models <b>PBL : Infertility (R3)</b> <b>STSE : Contraception (R2)</b>
		IIIId Coordination and response	Examination of a human eye model Investigation of the phototropic responses of shoots and roots Examination of a human ear / brain model Electrical Stimulation of a Frog's Leg	NHB : Irritability in Plant <b>PBL : Bean Sprouts (R3)</b>
	II. Genetics and Evolution	IIc Biodiversity and evolution Diversity of life forms Classification of organisms	<b>SBA 2: Amount of catalase in plant specimen</b>  Using a key to identify organisms from a local Habitat Constructing a dichotomous key for leaves	NHB : Insulin Discovery
III. Organisms and Environment	IIIIf Ecosystems	Ecology study of a local habitat	<b>NHB : Predator-prey relationship (R1)</b> <b>STSE : Action Blue Sky (R2)</b>	

S6	IV. Health and Diseases	IVa	Personal health	Ethanol effect on <i>Artemia</i> heart rate	PBL : Food Poisoning Detective <b>STSE : Infectious Diseases (R2)</b> <b>PBL : Tetanus (R3)</b>  <b>NHB : Mendelian Genetics (R1)</b> <b>NHB : Uncover the structure of DNA (R1)</b> <b>PBL : DNA Fingerprinting (R3)</b> <b>STSE : Human Genome Project (R2)</b>
		IVb	Diseases	<b>SBA 3: Determine the water potential of plant cells</b>  Observation of maize cobs with grains of different colours Observation and analysis of continuous variation in humans/ discontinuous variation in humans Separation of DNA fragments using gel electrophoresis	
	II. Genetics and Evolution	IIa	Basic genetics		
		IIb	Molecular genetics		
		IIc	Biodiversity and evolution Origin of life Evolution	<b>SBA 4: Compare the rate of transpiration in two plants</b>	

**Remarks:**

1. *Topics in italics and blue are foundation topics.*

2. EDB resources:

(R1) Curriculum Resources for Infusing Ideas about Nature and History of Biology and Scientific Inquiry into the Learning and Teaching of Senior Secondary Biology Curriculum (NHB)

(R2) Curriculum Resources for Infusing Science-Technology-Society-Environment Connections into the Learning and Teaching of the Senior Secondary Biology Curriculum (STSE)

(R3) Learning and Teaching Resources for Senior Secondary Biology Curriculum: Problem-based Learning (PBL)

(R4) Investigative Lab

### Appendix 3

Mark award for communication:

Mark	Clarity of expression and relevance to the question	Logical and systematic presentation
3	<ul style="list-style-type: none"><li>• Answers are easy to understand. They are fluent showing good command of language.</li><li>• There is no or little irrelevant material.</li></ul>	<ul style="list-style-type: none"><li>• Answers are well structured showing coherence of thought and organisation of ideas.</li></ul>
2	<ul style="list-style-type: none"><li>• Language used is understandable, but there is some inappropriate use of words.</li><li>• A little irrelevant material is included, but does not mar the overall answer.</li></ul>	<ul style="list-style-type: none"><li>• Answers are organised, but there is some repetition of ideas.</li></ul>
1	<ul style="list-style-type: none"><li>• Markers have to spend some time and effort on understanding the answer(s).</li><li>• Irrelevant material obscures some minor ideas.</li></ul>	<ul style="list-style-type: none"><li>• Answers are a bit disorganised, but paragraphing is evident. Repetition is noticeable.</li></ul>
0	<ul style="list-style-type: none"><li>• Language used is incomprehensible.</li><li>• Irrelevant material buries the major ideas required by the question.</li></ul>	<ul style="list-style-type: none"><li>• Ideas are not coherent and systematic. Candidate shows no attempt to organise thoughts.</li></ul>

## Appendix 4

### Students' Performance in Biology:

Level (Year)	Passing Percentage	Credit Percentage
S4 (2009-10) Final Examination	73.3%	13.3%
S5 (2010-11) First Examination	90.0%	36.7%