Syllabus

Overview

The StemCo syllabus is inspired by the Singapore education curriculum. Singapore is known for its excellence in PISA tests for both Sciences and Mathematics for the last few years. Results from PISA indicate the quality and equity of learning outcomes attained around the world. By adopting the Singapore education curriculum as a reference, StemCo provides an opportunity for students globally to learn from one of the best practices of education in the world.

Our approach prioritizes understanding, application, and analysis of scientific and mathematical concepts over rote memorization of factual material. This shift in focus is intentional, recognizing the need for students to develop skills with long-term value in an increasingly technological world. Rather than concentrating on large volumes of factual information with limited short-term relevance, StemCo emphasizes critical thinking and practical application of learned concepts.

Categories and Exam Format

This document outlines the syllabus for each StemCo Biology category. The corresponding international grade levels and their Singapore grade-level equivalents are provided below for

Category	International Grade Level	Singapore Grade Level Equivalent	Number of Questions (MCQ)	Exam Duration (Minutes)
Singa Junior	9-10	Secondary 3-4	40	120
Singa Senior	11-12	Junior College 1-2	40	120

reference. All categories are assessed entirely through **Multiple-Choice Questions (MCQs)**.

Syllabus

The StemCo syllabus is designed to cover essential areas and concepts crucial for a holistic understanding of subjects. While it provides a general framework for the topics featured in StemCo competitions, it is not intended to be exhaustive or overly detailed. Our goal is to provide an opportunity for students that encourages deep comprehension and real-world problem-solving, preparing them for future success in dynamic and unpredictable environments.

The syllabus includes a category called "Others" for concepts that don't fit into the main topics. This section may include questions about recent advancements, trends, and discoveries related to the subject area, designed to be inspiring. Questions in this category can also be more advanced.

Singa Junior

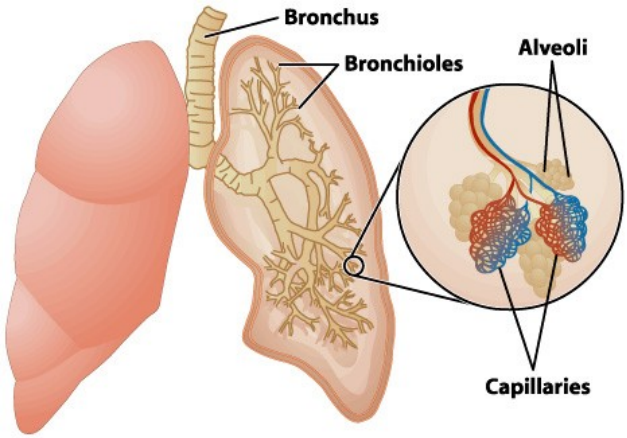
Areas	Concepts
Cells	Organelles (Grade 7-8 + Mitochondria, Endoplasmic

	Reticulum, Golgi Body & Ribosomes - Functions & Identification), Specialized Cells e.g., Neurons, RBCs
Biological Chemistry	Carbohydrates, Fats, Proteins, (including Benedict's Test, Ethanol, Starch, Biuret Solution), Enzymes, Diffusion, Osmosis, Active Transport
Digestive System	Stomach, Liver, Pancreas, Anus etc.; Enzymes (Lipase, Amylase etc.), Intestinal Peristalsis, Villus, Alcoholism
Circulatory System	Blood Vessels, RBCs & A/B/O Types, Transfusions, WBCs, Platelets, Plasma, Cardiac Cycle, Heart Disease
Respiratory System	Lungs (Bronchioles, Alveoli etc.), Trachea, Diaphragm, Cilia, Ribs, Intercostal Muscles, Tobacco Smoke
Urinary System	Bladder, Kidney & Nephrons, Ultrafiltration, Dialysis
Homeostasis	Body's Thermostat, Hypothalamus, Endocrine Glands, Hormones, Insulin, ADH, Nervous System, Eyes
Ecology	Photosynthesis, Respiration, Transpiration, Translocation, Food Chains, Energy Flows, Pollution
Infectious Diseases	Bacteria (Pneumococcus), Viruses (Influenza), Vaccine
Molecular Genetics	DNA & Base Pairs, Proteins, Mitosis, Meiosis, Genes & Alleles, Chromosomes, Natural Selection, Inheritance
Others	...

Sample Questions

1. Lungs' Aveoli

Our lungs are crucial to help us conduct gaseous exchange with our surroundings.



When we breathe, gaseous exchange occurs in small air sacs, known as alveoli, in our lungs. Oxygen from the air diffuses into our bloodstream, and carbon dioxide diffuses out.

Which of the following is NOT a characteristic of the alveoli that ensures their effectiveness in gaseous exchange?

(a) Small surface area to volume ratio

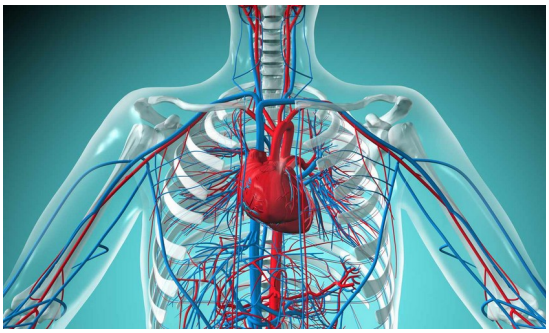
(b) Thin walls

(c) Highly vascularised

(d) Moist surface

2. Red Blood Cells

Blood in the Human Circulatory System is responsible for transport of Oxygen and nutrients around the body, as well as the removal of waste products e.g., Carbon Dioxide.



In blood, there are 4 components: Red Blood Cells, White Blood Cells, Plasma and Platelets. The Red Blood Cells are important in transporting oxygen around the body.

Which of the following is a correct description of an adaptation of red blood cells to increase their oxygen carrying capacity?

(a) They contain a Golgi apparatus to produce more haemoglobin.

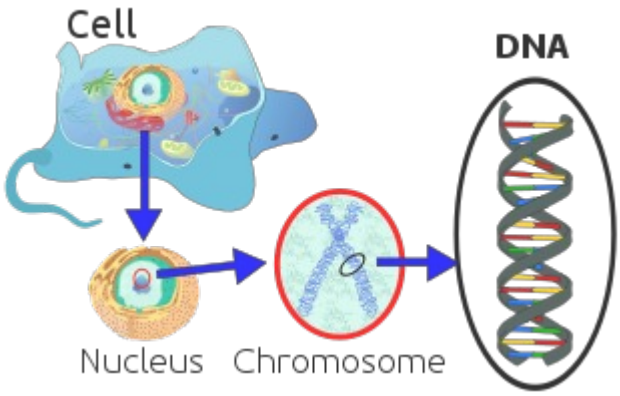
(b) They do not have a nucleus to contain more haemoglobin.

(c) They contain mitochondria to absorb more oxygen actively.

(d) They do not have a cell membrane to allow for easier entry of oxygen.

3. Nucleotides in DNA

Deoxyribonucleic acid (DNA) is the hereditary material that can be found in all living organisms. It is made up of two strands of polynucleotide chains that form a double-helix structure.



Given that DNA is only made up of deoxyribonucleotides, which of the following nucleotides is not found in DNA?

(a) Uracil

(b) Adenine

(c) Cytosine

(d) Guanine

Singa Senior

Areas	Concepts
Cells	Cell Theory, Fluid-Mosiac Model, Organelles (Functions & Identification - Electron Microscope Included), Stem Cells, Bacteria, Viruses, Enzymes, Monomers (e.g., α/β-Glucose, Glycerol etc. & Bonding), Bio-Molecules (e.g., Cellulose, TG), Processes (Osmosis, Exocytosis etc.)
Molecular Genetics	DNA - Structure & Function, Central Dogma, Genomes (Viral, Prokaryotic, Eukaryotic), Antigenic Shift & Drift, Gene Expression & Regulation; F-Plasmids, Lab Techniques - PCR, Gel Electrophoresis, Southern Blot
Inheritance	Gene Mutation & Chromosomal Aberration, Mitotic & Meiotic Cell Cycle, Cancer, Tumor-Suppressor & Proto-Oncogenes, Genotype & Phenotype, Genetic Diagrams, Dihybrid Crosses, Loci & Epistasis, χ^2-Tests
Energy	Photosynthetic Pigments (& Absorption Spectra), Calvin Cycle, ETC, Glycolysis, Link Reaction, Krebs Cycle, Cell-Signalling, Oxidative Phosphorylation, Chemiosmosis
Neo-Darwinism	Evolution, Natural Selection, Variation, Allopatric & Sympatric Speciation, Phylogeny, Hardy-Winberg Model
Infectious Diseases	Adaptive & Innate Immunity, Antibodies, Somatic Recombination, Class- Switching, Hyper-Mutation, HIV & Influenza, Vaccination, Tuberculosis, Antibiotics, R_0
Climate Change	Anthropogenic Impacts, Mangrove Ecosystems, Impact on Biodiversity, Medicines & Food Supply, Mosquito-Borne Infectious Diseases (Dengue & Malaria)
Others	...

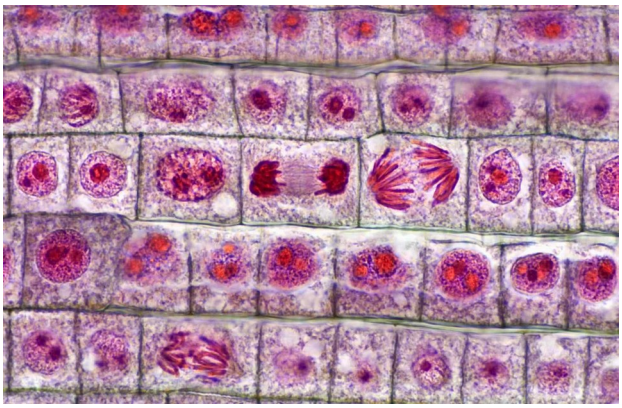
Sample Questions

1. Omnis Cellula e Cellula

Cells are very small but they are very important. They are the basic unit of all living organisms. Moreover, there is a whole theory dedicated to them - **Cell Theory**.

There are 3 main principles stated in this theory:

1. All living organisms are made from cells.
2. Cells are the basic functional unit in living organisms.
3. All cells come from pre-existing cells.



Using the above image only, how many of the main principles of Cell Theory are depicted?

(a) 0

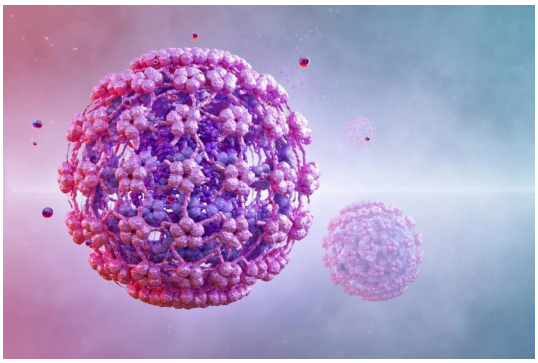
(b) 1

(c) 2

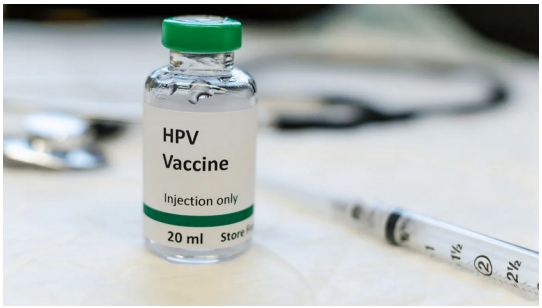
(d) 3

2. Virus-Associated Cancer

Infection by some viruses may predispose patients to developing cancer. One of the most common virus-associated cancers is cervical cancer, caused by infection with the Human Papillomavirus (HPV).



Therefore, due to the above phenomenon, females in Singapore are encouraged to obtain HPV vaccination to reduce their risk of cervical cancer.



When HPV integrates its genome into DNA, the cell cycle may be affected. Which of the following events is most likely to result in cancer development?

(a) Integration of HPV DNA disrupts the silencer region of a proto-oncogene.

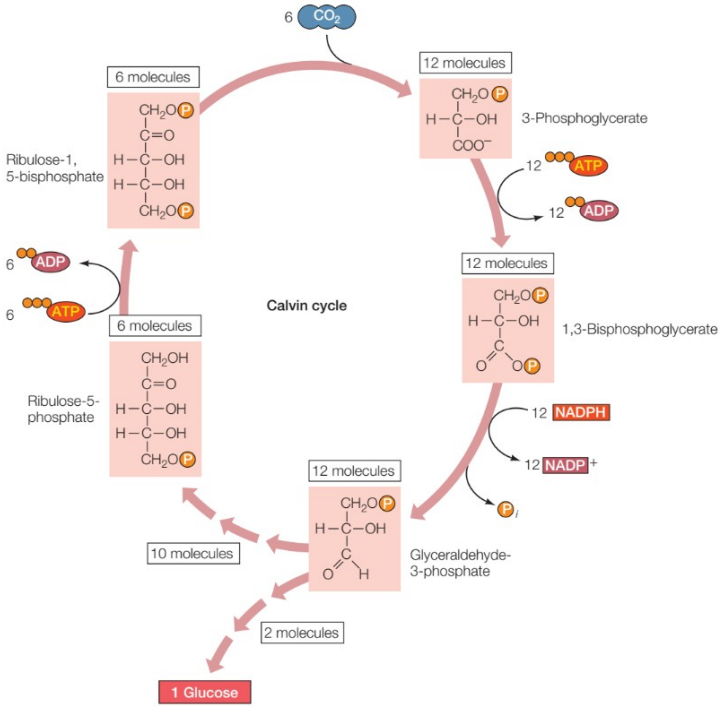
(b) Integration of HPV DNA disrupts the promoter region of a gene which prevents apoptosis.

(c) Integration of HPV DNA disrupts the silencer region of a tumour suppressor gene.

(d) Integration of HPV DNA disrupts the enhancer region of a gene which increases cell division.

3. The Calvin Cycle

The Calvin cycle is the chain of chemical reactions that are light-independent but use molecules of ATP and NADPH from the light-dependent reactions to make carbohydrates.



How many molecules of ribulose can be made if initially we have 3 molecules of CO2 and only 6 molecules of ATP and NADPH made from the light-dependent reaction?

(a) 1

(b) 2

(c) 3

(d) 6