Kilbaha Biology

VCE Unit 1

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Cover Image: The life of a bee is very different from the life of a flower, but the two organisms are related. Both are members the domain Eukarya and have cells containing many similar organelles, genes, and proteins. (credit: modification of work by John Beetham)

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How do living things stay alive?

Authors’ Note to Biology, Chemistry, Physics Teachers – Unit 1

- Ian Alexander, Alan Reynolds and Bill Healy as the authors and editors of this series have been motivated to complete this project by the new Study Guides for the VCE sciences for the period 2016 - 2021.

- Teachers will find that the content of these books goes well beyond the content of standard Year 11 Textbooks. We believe this will suit the new emphasis on research and investigation in the new Study Guides. We also expect these books to have wide application to other Australian Biology, Chemistry and Physics courses.

- We are keen to provide all schools with quality material at a bargain basement price.

- We have been able to do this because of the relationship between Kilbaha Multimedia Publishing in Australia and OpenStax in the United States. We are grateful to OpenStax for their support. It has taken considerable work to make these texts Australian in word and context and to meet the expectations of the new VCE courses commencing in 2016.

- Try to think of these electronic books in a different way. They are like Apps on your smartphone. These are just versions 1.1 and we envisage that additional material (free to all subscribers) will be added after feedback from teachers.

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- Ian Alexander, Alan Reynolds and Bill Healy hope that you find these electronic books a valuable addition to your teaching materials for Year 11 and Year 12 or wherever else you choose to use them within your school.

- Please support us in this project by respecting the licence conditions. They are extremely generous and flexible.

- We will, of course, be delighted if you tell your colleagues about these books.

CHAPTER 1

THE STUDY OF LIFE

Figure 1.1 This NASA image is a composite of several satellite-based views of Earth. To make the whole-Earth image, NASA scientists combine observations of different parts of the planet. (credit: NASA/GSFC/NOAA/USGS)

Chapter Outline

1.1: The Science of Biology

1.2: Themes and Concepts of Biology

Introduction

Viewed from space, Earth offers no clues about the diversity of life forms that reside there. The first forms of life on Earth are thought to have been microorganisms that existed for billions of years in the ocean before plants and animals appeared. The mammals, birds, and flowers so familiar to us are all relatively recent, originating 130 to 200 million years ago. Humans have inhabited this planet for only the last 2.5 million years, and only in the last 200,000 years have humans started looking like we do today.

CHAPTER 2

CELL STRUCTURE

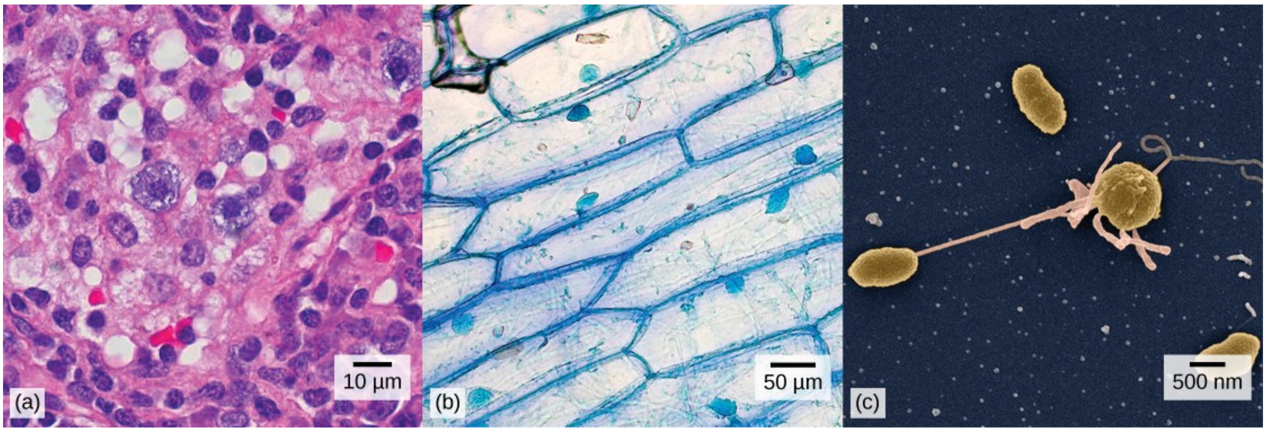

Figure 2.1 (a) Nasal sinus cells (viewed with a light microscope), (b) onion cells (viewed with a light microscope), and (c) *Vibrio tasmaniensis* bacterial cells (seen through a scanning electron microscope) are from very different organisms, yet all share certain characteristics of basic cell structure. (credit a: modification of work by Ed Uthman, MD; credit b: modification of work by Umberto Salvagnin; credit c: modification of work by Anthony D'Onofrio, William H. Fowle, Eric J. Stewart, and Kim Lewis of the Lewis Lab at Northeastern University; scale-bar data from Matt Russell)

Chapter Outline

2.1: Studying Cells

2.2: Prokaryotic Cells

2.3: Eukaryotic Cells

2.4: The Endomembrane System and Proteins

2.5: The Cytoskeleton

2.6: Connections between Cells and Cellular Activities

CHAPTER 3

STRUCTURE AND FUNCTION OF PLASMA MEMBRANES

Figure 3.1 Despite its seeming hustle and bustle, Grand Central Station functions with a high level of organisation: People and objects move from one location to another, they cross or are contained within certain boundaries, and they provide a constant flow as part of larger activity. Analogously, a plasma membrane's functions involve movement within the cell and across boundaries in the process of intracellular and intercellular activities. (credit: modification of work by Randy Le'Moine)

Chapter Outline

Introduction

The **plasma membrane**, which is also called the cell membrane, has many functions, but the most basic one is to define the borders of the cell and keep the cell functional. The plasma membrane is **selectively permeable**. This means that the membrane allows some materials to freely enter or leave the cell, while other materials cannot move freely, but require the use of a specialised structure, and occasionally, even energy investment for crossing.

CHAPTER 4

METABOLISM

Figure 4.1 A hummingbird needs energy to maintain prolonged periods of flight. The bird obtains its energy from taking in food and transforming the nutrients into energy through a series of biochemical reactions. The flight muscles in birds are extremely efficient in energy production. (credit: modification of work by Cory Zanker)

Chapter Outline

CHAPTER 5

STRUCTURE AND FUNCTION OF VASCULAR PLANTS

Figure 5.1 A locust leaf consists of leaflets arrayed along a central midrib. Each leaflet is a complex photosynthetic machine, exquisitely adapted to capture sunlight and carbon dioxide. An intricate vascular system supplies the leaf with water and minerals, and exports the products of photosynthesis. (credit: modification of work by Todd Petit)

Chapter Outline

CHAPTER 6

ANIMAL NUTRITION - THE MAMMALIAN DIGESTIVE SYSTEM

Figure 6.1 For humans, fruits and vegetables are important in maintaining a balanced diet.
(credit: modification of work by Julie Rybarczyk)

Chapter Outline

CHAPTER 7

THE MAMMALIAN RESPIRATORY SYSTEM

Figure 7.1 Lungs, which appear as nearly transparent tissue surrounding the heart in this X-ray of a dog (left), are the central organs of the respiratory system. The left lung is smaller than the right lung to accommodate space for the heart. A dog's nose (right) has a slit on the side of each nostril. When tracking a scent, the slits open, blocking the front of the nostrils. This allows the dog to exhale though the now-open area on the side of the nostrils without losing the scent that is being followed. (credit a: modification of work by Geoff Stearns; credit b: modification of work by Cory Zanker)

Chapter Outline

Introduction

Breathing is an involuntary action. How often a breath is taken and how much air is inhaled or exhaled are tightly regulated by the respiratory centre in the brain. Humans, when they aren't exerting themselves, breathe approximately 15 times per minute on average. Canines, like the dog in **Figure 7.1**, have a respiratory rate of about 15–30 breaths per minute. With every inhalation, air fills the lungs, and with every exhalation, air rushes back out. That air is doing more than just inflating and deflating the lungs in the chest cavity. The air contains oxygen that crosses the lung tissue, enters the bloodstream, and travels to organs and tissues. Oxygen (O2) enters the cells where it is used for metabolic reactions that produce ATP, a high-energy compound. At the same time, these reactions release carbon dioxide (CO2) as a by- product. CO2 is toxic and must be eliminated. Carbon dioxide exits the cells, enters the bloodstream, travels back to the lungs, and is expired out of the body during exhalation.

CHAPTER 8

THE MAMMALIAN CIRCULATORY SYSTEM

Figure 8.1 Just as highway systems transport people and goods through a complex network, the circulatory system transports nutrients, gases, and wastes throughout the animal body. (credit: modification of work by Andrey Belenko)

Chapter Outline

CHAPTER 9

MAMMALIAN OSMOTIC REGULATION AND EXCRETION

Figure 9.1 Just as humans recycle what we can and dump the remains into landfills, our bodies use and recycle what they can and excrete the remaining waste products. Our bodies' complex systems have developed ways to treat waste and maintain a balanced internal environment. (credit: modification of work by Redwin Law)

Chapter Outline

9.1: Osmoregulation and Osmotic Balance

9.2: The Kidneys and Osmoregulatory Organs

9.3: Nitrogenous Wastes

9.4: Hormonal Control of Osmoregulatory Functions

Introduction

The daily intake recommendation for human water consumption is eight to ten glasses of water. In order to achieve a healthy balance, the human body should excrete the eight to ten glasses of water every day. This occurs via the processes of urination, defecation, sweating and, to a small extent, respiration. The organs and tissues of the human body are soaked in fluids that are maintained at constant temperature, pH, and solute concentration, all crucial elements of homeostasis. The solutes in body fluids are mainly mineral salts and sugars, and osmotic regulation is the process by which the mineral salts and water are kept in balance. Osmotic homeostasis is maintained despite the influence of external factors like temperature, diet, and weather conditions.

CHAPTER 10
SURVIVAL THROUGH ADAPTATIONS AND REGULATION

Figure 10.1: Tigers, polar bears and orang-utans get a lot of attention when threats to biodiversity. However, what about all the other organisms? Can you think of 10 non mammals that are under threat of extinction?
http://www.theguardian.com/environment/blog/2010/oct/01/live-ahmed-djoghlaf-un-biodiversity

Chapter Outline

10.1: Adaptations

10.2: Adaptations in plants

10.3: Adaptations in animals

10.4: Biomimicry

10.5: Homeostasis (temperature, glucose and water balance)

Introduction

All organisms are on this planet because they are perfectly adapted to the environment that they inhabit. This is a complex interaction which leads to adaptations that enhance their survival. It is incorrect to say that an adaptation is something that changes because the organism already possesses it. Evolution ‘prunes’ and ‘sculpts’ populations over time through a process known as natural selection. Only those organisms strong enough to survive and reproduce can pass on their adaptations. The world’s biodiversity is in a delicate balance between their environment and the impact humans are having on them. Figure 10.1 portrays some organisms that are threatened but without intervention they may become extinct, some even before they are discovered!

CHAPTER 11

ORGANISING BIODIVERSITY

Figure 11.1 The life of a bee is very different from the life of a flower, but the two organisms are related. Both are members the domain Eukarya and have cells containing many similar organelles, genes, and proteins. (credit: modification of work by John Beetham)

Chapter Outline

11.1: Organising Life on Earth

11.2: Prokaryotes

11.3: Eukaryotes

11.4: Eukaryotes that have Backbones

Introduction

This bee and *Echinacea flower* (**Figure 11.1**) could not look more different, yet they are related, as are all living organisms on Earth. By following pathways of similarities and changes—both visible and genetic—scientists seek to map the evolutionary past of how life developed from single-celled organisms to the tremendous collection of creatures that have germinated, crawled, floated, swam, flown, and walked on this planet.

CHAPTER 12

CONSERVATION BIOLOGY AND BIODIVERSITY

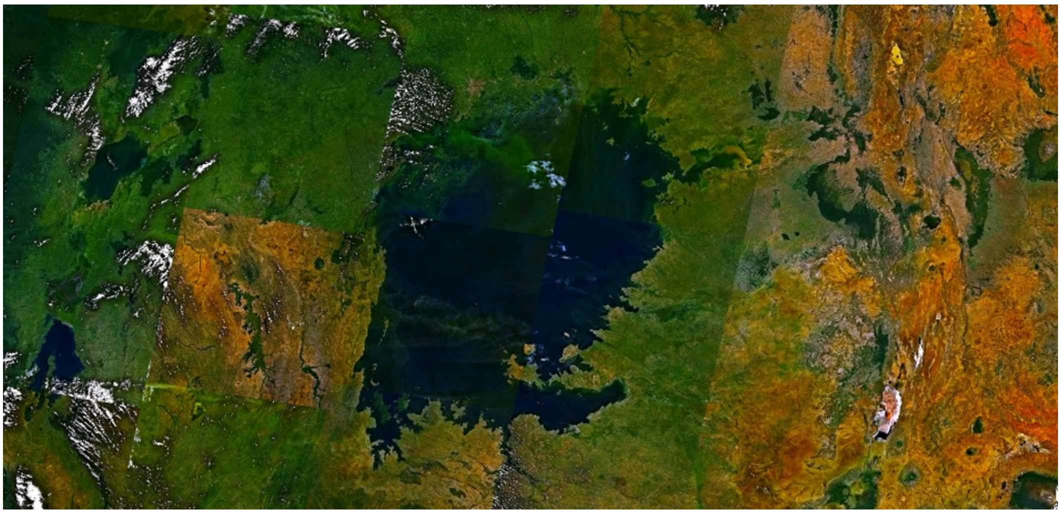

Figure 12.1 Lake Victoria in Africa, shown in this satellite image, was the site of one of the most extraordinary evolutionary findings on the planet, as well as a casualty of devastating biodiversity loss. (credit: modification of work by Rishabh Tatiraju, using NASA World Wind software)

Chapter Outline

Introduction

In the 1980s, biologists working in Lake Victoria in Africa discovered one of the most extraordinary products of evolution on the planet. Located in the Great Rift Valley, Lake Victoria is a large lake about 68,900 km2 in area (larger than Lake Huron, the second largest of North America's Great Lakes). Biologists were studying species of a family of fish called cichlids. They found that as they sampled for fish in different locations of the lake, they never stopped finding new species, and they identified nearly 500 evolved types of cichlids. But while studying these variations, they quickly discovered that the invasive Nile Perch was destroying the lake's cichlid population, bringing hundreds of cichlid species to extinction with devastating rapidity.

CHAPTER 13 ECOLOGY

THE RELATIONSHIPS BETWEEN ORGANISMS AND ECOSYSTEMS

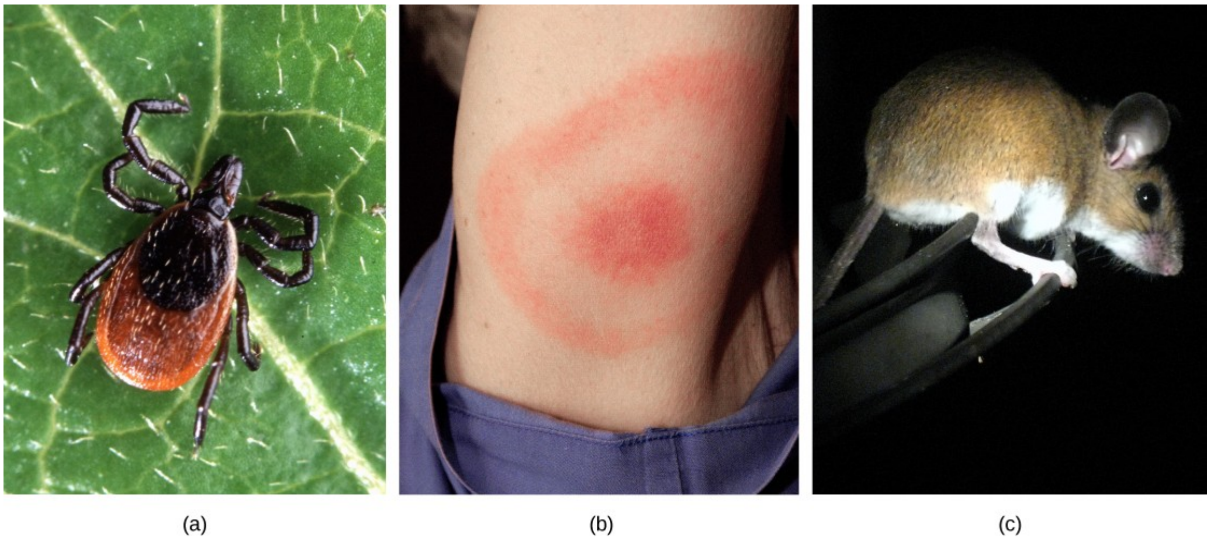

Figure 13.1 The (a) deer tick carries the bacterium that produces Lyme disease in humans, often evident in (b) a symptomatic bull's eye rash. The (c) white-footed mouse is one well-known host to deer ticks carrying the Lyme disease bacterium. (credit a: modification of work by Scott Bauer, USDA ARS; credit b: modification of work by James Gathany, CDC; credit c: modification of work by Rob Ireton)

Chapter Outline

13.1: The Scope of Ecology

13.2: Relationships between species

13.3: Food web ecology

13.4: Energy Flow Through Ecosystems

CHAPTER 14

POPULATION AND COMMUNITY ECOLOGY

Figure 14.1 A photograph of 10 koalas in eucalypt trees at Cape Otway. They have been culled in the area so that the balance in the community can be retained.
http://www.theage.com.au/victoria/hundreds-of-starving-cape-otway-koalas-killed-in-secret-culls-20150304-13un49.html

Chapter Outline

14.1: Population Demography

14.2: Environmental Limits to Population Growth

14.3: Population Dynamics and Regulation

14.4: Human Population Growth

Introduction

Imagine hiking through the Otway Ranges in western Victoria and regularly stopping to take in the Australian views, which includes the iconic koala. However, recently (2013/2014) more than 686 starving koalas were killed in secret culls in the Cape Otway area. The marsupials were starving due to overpopulation in the Cape region, which is said to have the greatest density of koalas in Australia. The secret cull was conducted to address overpopulation issues. The koalas were captured and sedated before being put down. This seems an extraordinary action taken; however, the koala population forms part of the delicate balance that exists in nature.

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