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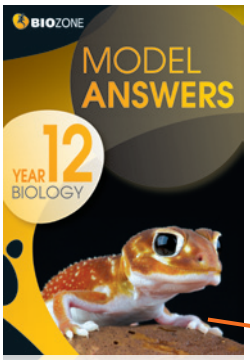

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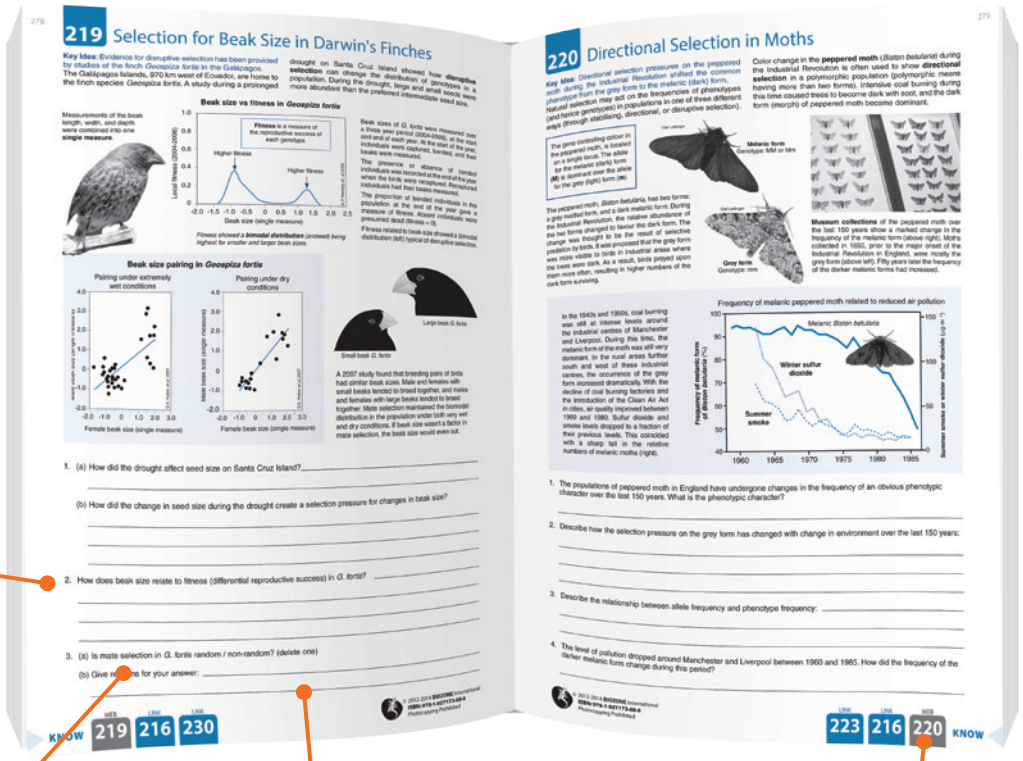

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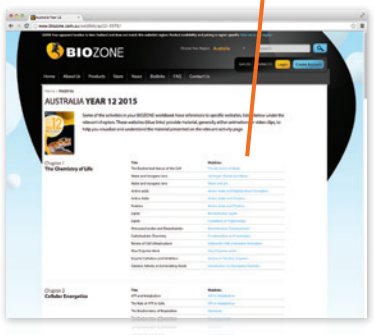

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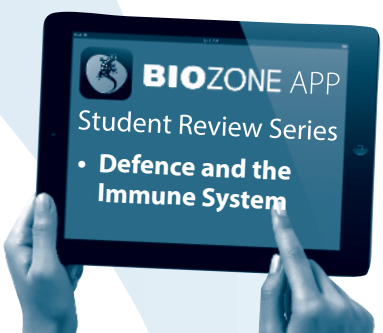
QLD As required
VCE Unit 3 (2)
WA ATAR Unit 4
SA Theme O

Defence and the Immune System

Key terms

active immunity
allergic reaction
antibody (=immunoglobulin)
antigen
asthma
autoimmune disease
B cell (=B lymphocyte)
cell-mediated immunity
clonal selection
fever
hayfever
histamine
humoral immunity
hypersensitivity
immunity
immunological memory
infection
inflammation
interferon
leucocyte
lymphocyte
macrophage
MHC
monoclonal antibody
non-specific defences (=innate immunity)
passive immunity
phagocyte
primary response
secondary response
specific (=adaptive) immune response
T cell (=T lymphocyte)
thymus
vaccination (=immunisation)

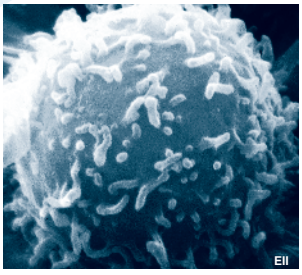


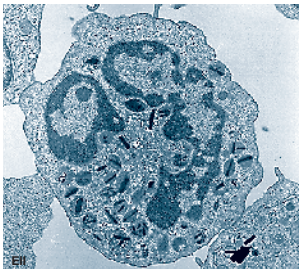
The body's layers of defence

Learning aims and skills

Activity number

- ☐ 1 Describe the range of physical and chemical defences in animals. — 91
- ☐ 2 Explain how the body distinguishes self from non-self. Include reference to the role of the major histocompatibility complex (MHC) and its role in self-recognition and in determining tissue compatibility in transplant recipients. — 92
- ☐ 3 Explain the basis of the Rh and ABO blood group systems in humans. Explain the consequences of blood type incompatibility in blood transfusions. — 93
- ☐ 4 Describe non-specific (innate) defences in humans, describing the nature and role of each of the following in protecting against pathogens:
  (a) Skin (including sweat and sebum production) and mucous membranes.
  (b) Body secretions (tears, urine, saliva, gastric juice).
  (c) Natural anti-bacterial and anti-viral proteins, e.g. interferon.
  (d) Phagocytosis, the inflammatory response, fever, and cell death. — 94 -97





Specific immunity

Learning aims and skills

Activity number

- ☐ 5 Describe the specific immune response, including the role of specificity and memory. Describe cell-mediated immunity and humoral (antibody-mediated) immunity, identifying the specific white blood cells involved in each case. — 98 99
- ☐ 6 Describe clonal selection and the basis of immunological memory. Explain how the immune system is able to respond to the large range of potential antigens. — 100
- ☐ 7 Explain antibody production, including how B cells bring about humoral (antibody-mediated) immunity to specific antigens — 101
- ☐ 8 Distinguish between naturally acquired and artificially acquired immunity and between active and passive immunity. — 102
- ☐ 9 Explain the principles of vaccination, including reference to the primary and secondary response to infection and the role of these. — 103
- ☐ 10 Describe the production and applications of monoclonal antibodies. — 104 105

Immune dysfunction and disease

Learning aims and skills

Activity number

- ☐ 11 With reference to specific examples, describe the result of immune system dysfunction, e.g. in hypersensitivity reactions such as asthma and hayfever, and in autoimmune diseases such as multiple sclerosis. — 106 107

Defence mechanisms in plants

Learning aims and skills

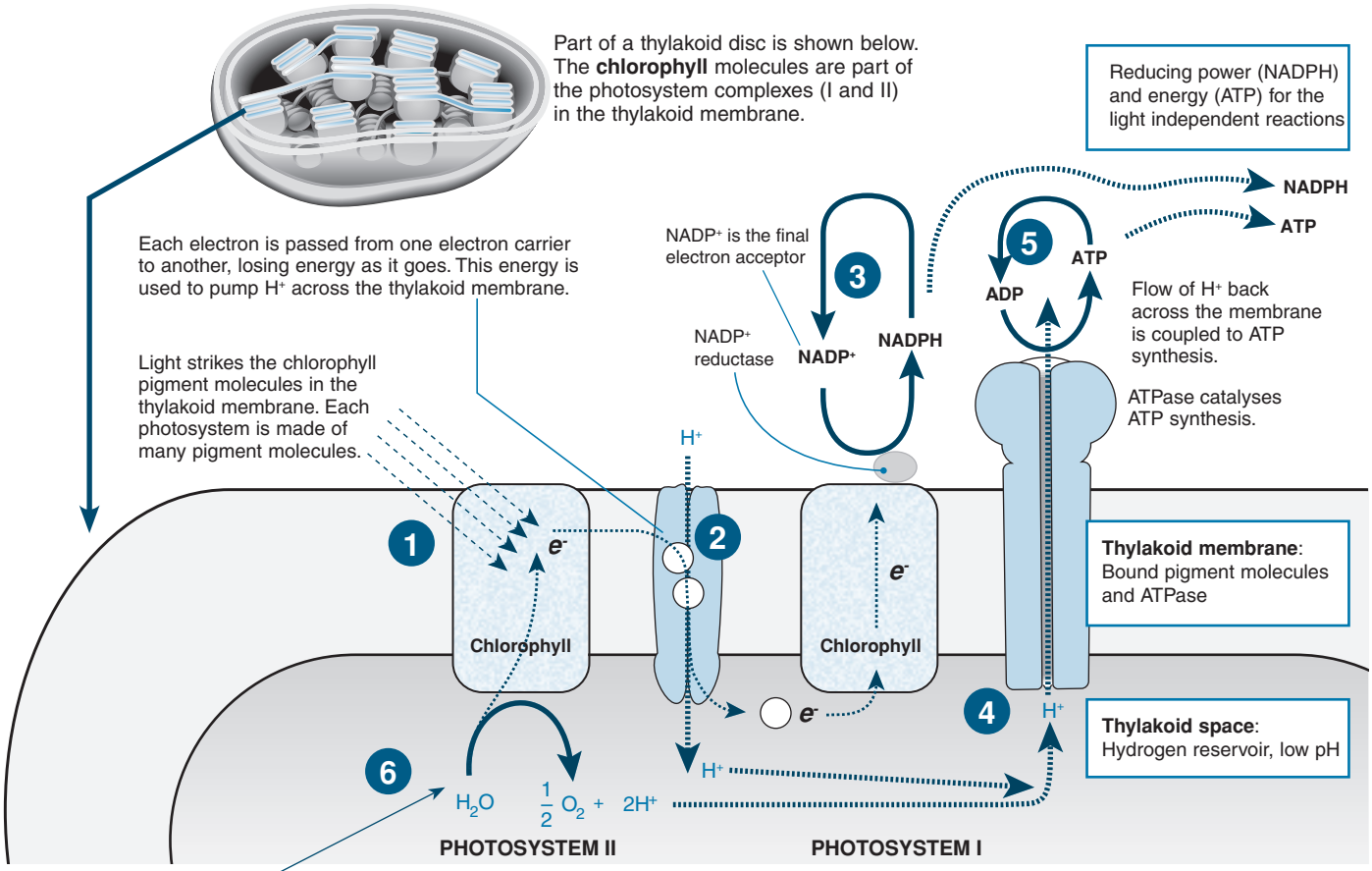
Activity number

- ☐ 12 Describe how plants inhibit disease and recover from infection. Describe passive and active defences in plants, including reference to physical and chemical barriers, cellular defences, and cell death (necrosis). — 108

35 Light Dependent Reactions

Key Idea: In the light dependent reactions of photosynthesis, the energy from photons of light is used to drive the reduction of $NADP^+$ and the production of ATP.

The process of photosynthesis occurs in two separate reaction systems. The light dependent reactions (the first of these) in the thylakoid of the chloroplasts capture light energy to produce **ATP** and reducing power (as **NADPH**) which is used in the light independent reactions (the second reaction system). The light dependent reactions take place in the thylakoids of the chloroplast (enlarged below).



1. Where do the light dependent reactions occur? _____

2. What is the role of each of the following in the light dependent reactions:

   (a) $NADP^+$ reductase: _____

   (b) ATPase (also called ATP synthase): _____

3. How are the electrons that are lost from the thylakoid system replaced? _____

4. Summarise the events of the light dependent reactions: _____

ISBN: 978-1-927173-97-8

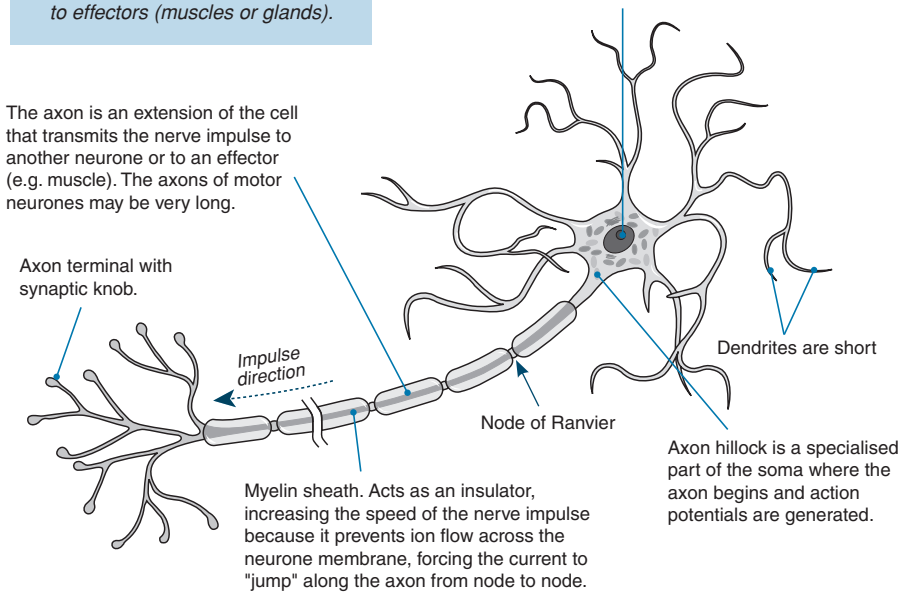
55 Neurones and Neurotransmitters

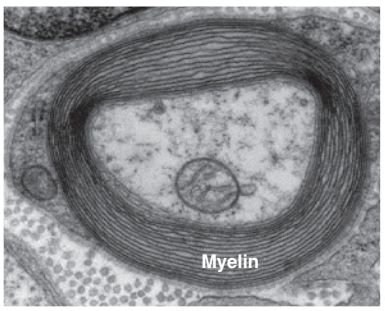
Key Idea: Neurones are electrically excitable cells that are specialised to process and transmit information via electrical and chemical signals. Neurotransmitters are chemicals that allow the transmission of signals between neurones.

Neurones are cells specialised to transmit information in the form of electrochemical signals from receptors (in the central nervous system) to effectors. Neurones consist of a cell body (soma) and long processes (dendrites and axons). Messages are transmitted between neurones by signalling molecules called neurotransmitters.

Motor (efferent) neurone

Transmits impulses from the CNS to effectors (muscles or glands).





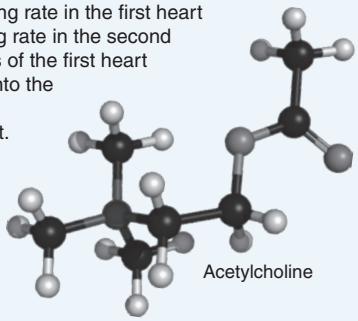
Roadnottaken

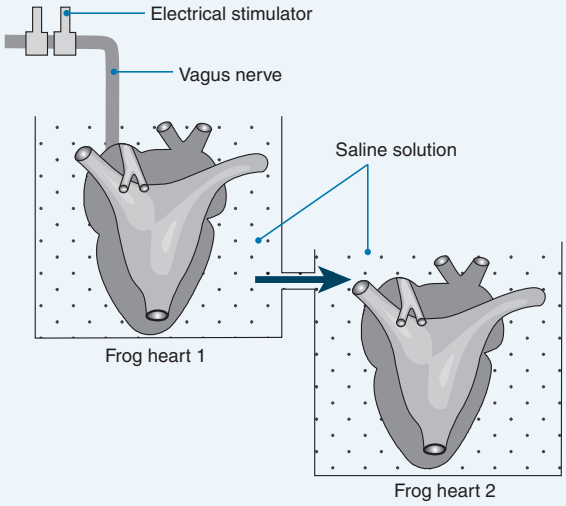
TEM cross section through a myelinated axon

Where conduction speed is important, the axons of neurones are sheathed within a lipid and protein rich substance called **myelin**. Myelin is produced by oligodendrocytes in the central nervous system (CNS) and by Schwann cells in the peripheral nervous system (PNS). At intervals along the axons of myelinated neurones, there are gaps between neighbouring Schwann cells and their sheaths. These are called **nodes of Ranvier**.

Neurotransmitters Carry Signals Between Neurones

Chemical signalling between neurones was first demonstrated in 1921 by Otto Loewi. In his experiment, the still beating hearts of two frogs were placed in connected flasks filled with saline solution. The vagus nerve (parasympathetic) of the first heart was still attached and was stimulated by electricity to reduce its rate of beating. After a delay, the rate of beating in the second heart also slowed. Increasing the beating rate in the first heart caused an increase in the beating rate in the second heart, showing electrical stimulus of the first heart caused it to release a chemical into the saline solution that then affected the heartbeat of the second heart. The chemical was found to be **acetylcholine**.





1. What is the function of a neurone? _____

_____

2. Describe the purpose of a neurotransmitter: _____

_____

3 (a) Explain why stimulating the first frog heart with electricity caused it to change its beating rate: _____

_____

_____

(b) Explain why the second heart in the experiment reduced its beating rate after a delay: _____

_____

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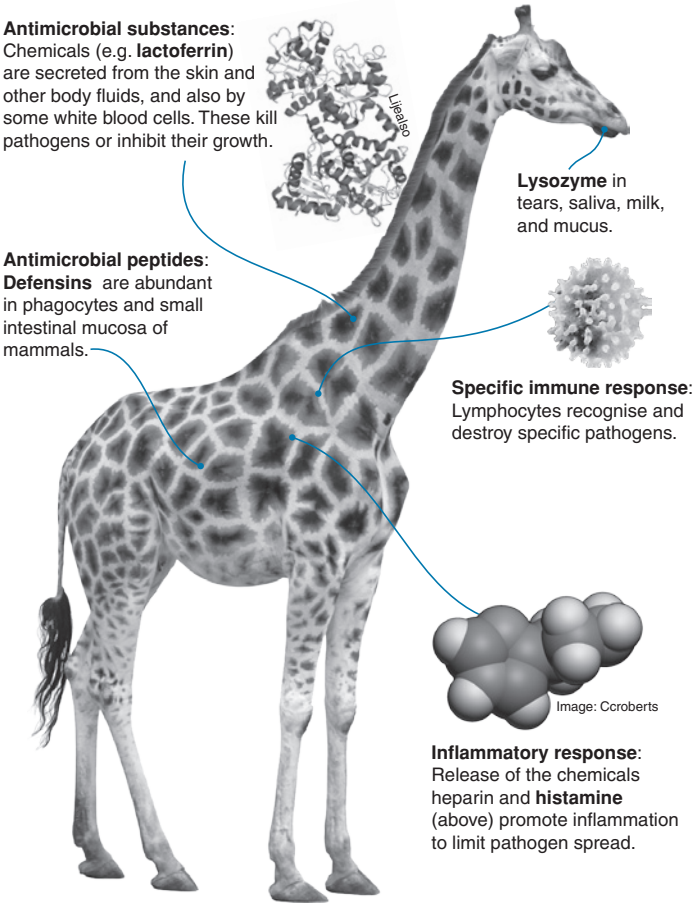
91 Chemical Defences In Animals

Key Idea: Animals have evolved a wide range of chemical defences that protect against infection by pathogens.

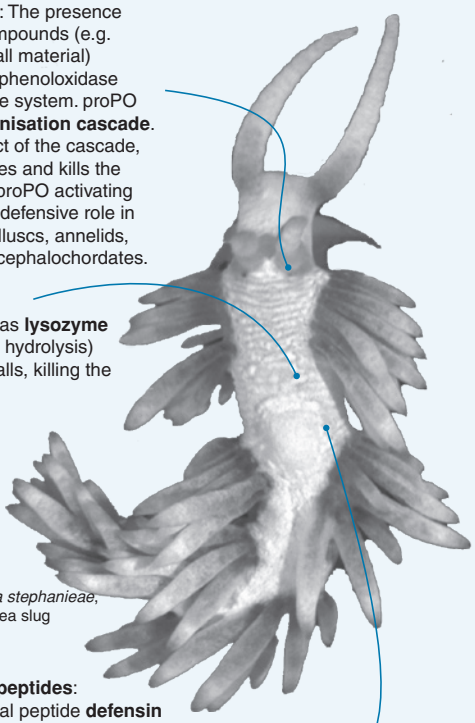
Living organisms are under constant attack from many different **pathogens** (disease causing organisms). As a result, they have evolved many ways to limit infection by pathogens.

Plants and animals have a number of defences, including **chemical defences**, to destroy pathogens. Invertebrates were initially thought to lack specific immunity, but recent findings suggest the opposite is true, although it is different to that seen in vertebrates.

Vertebrate Defences



Invertebrate Defences



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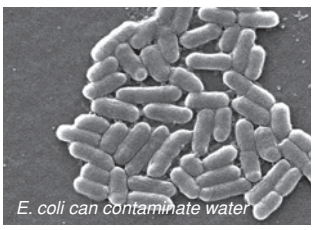
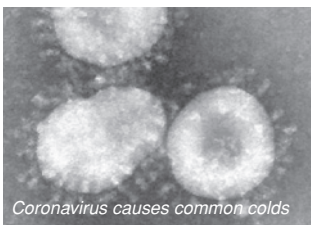
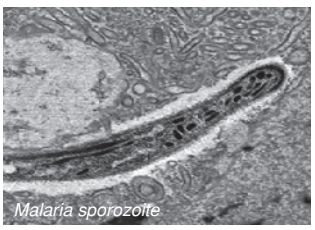


Pathogenic **bacteria** cause a wide range of diseases. Some types of *E. coli* are harmless gut residents, but others can cause disease.

Vertebrates and invertebrates are host to a range of arthropod vectors, which may carry pathogenic microorganisms on their mouthparts.



Viruses are species-specific intracellular parasites and cause many common diseases. They infect all other organisms, including bacteria.



Eukaryotic pathogens: protozoa (e.g. the malaria parasite above), algae, fungi, and parasitic worms, may be pathogenic.

1. (a) Describe the advantage of having multiple (non-specific) defence responses: _____

_____

_____

(b) Describe a disadvantage of having only general (non-specific) defence responses: _____

_____

2. Compare and contrast the non-specific defences of vertebrate and invertebrate animals: _____

_____

_____

_____

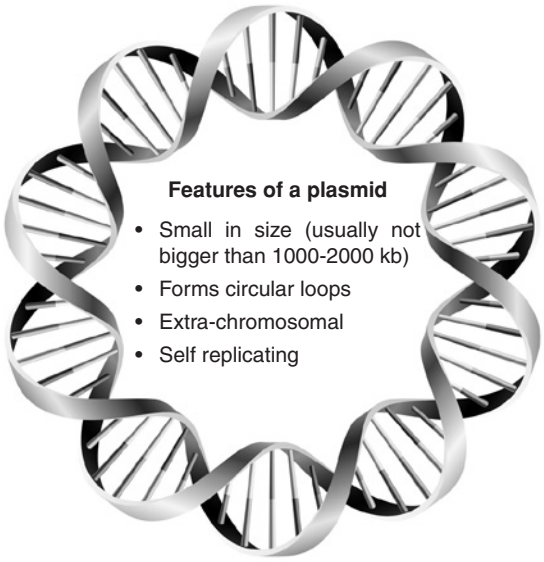
KNOW LINK 94 LINK 74

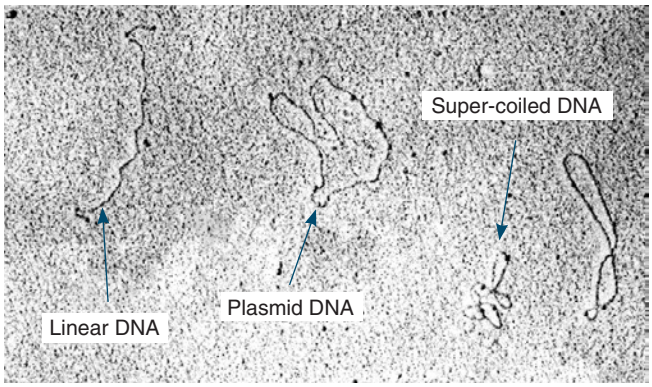
ISBN: 978-1-927173-97-8

113 Plasmid DNA

Key Idea: Plasmids are small circular pieces of DNA that are not associated with the chromosomal DNA.

Prokaryotes store most of their genetic information in one large chromosome. However, a small percentage can be found as independently replicating, circular, extra-chromosomal pieces of DNA known as **plasmids**. Plasmids may carry important genes, such as those for the production of toxins that eliminate prokaryote competitors. Plasmids are less common in eukaryotes but some species, such as the yeast *Saccharomyces,* do have them. The genetic material from viruses may form plasmid-like structures called episomes once they have infected a cell.





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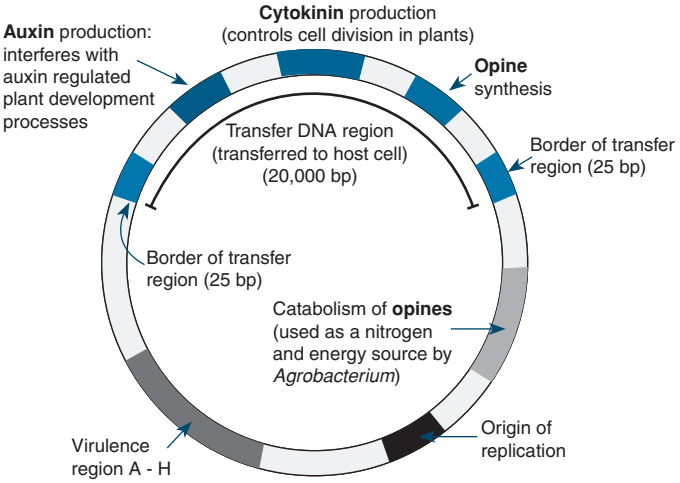
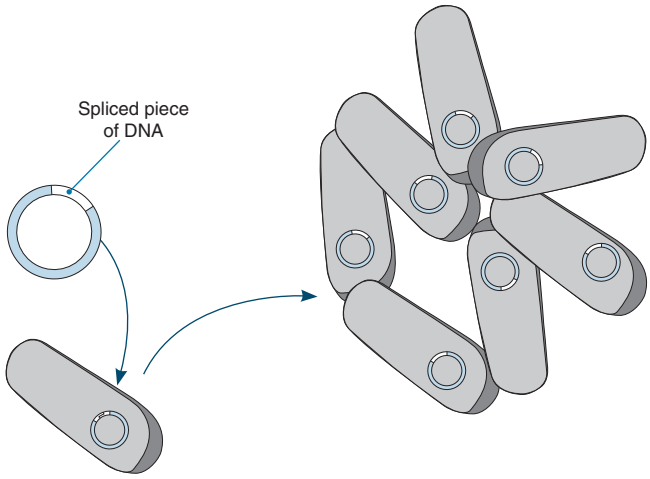
Plasmids vary in size from 1000 base pairs (bp) to hundreds of thousands of base pairs. In bacteria, they play an important role in providing extra genetic material that confers properties such as antibiotic resistance.

Plasmids can be transferred between bacterial cells by a process of plasmid transfer called **conjugation**. Conjugation enables bacteria to obtain genetic material from other individuals by **horizontal gene transfer** (transfer of genetic material to individuals other than offspring) and it is an important mechanism for the spread of antibiotic resistance.



The bacterium *Agrobacterium tumefaciens* often contains the T*i* (tumour inducing) plasmid. This plasmid is able to transfer genetic material into plant cells and causes crown gall disease. Several regions on the plasmid (identified above) help it to infect plants. The plasmid is just over 200,000 bp long and contains 196 genes. The mapping of its genes has made it of great importance in the creation of transgenic plants.



Plasmids have provided a tool with which to introduce novel genetic material into an organism. A new gene can be spliced into a plasmid and the plasmid inserted into a recipient organism (e.g. a bacterium). The bacteria will then produce the product encoded by the gene. This methodology has enabled the industrial-scale production of valuable gene products, such as human insulin, from genetically engineered organisms.

1. What is a plasmid? _____

_____

2. Explain how a plasmid can convey a survival advantage to bacteria under certain conditions: _____

_____

_____

3. (a) Why are plasmids (such as the T*i* plasmid) useful to genetic engineers? _____

_____

(b) Into which region of the T*i* plasmid would you insert a gene in order for it to be transferred into a host plant cell?

_____

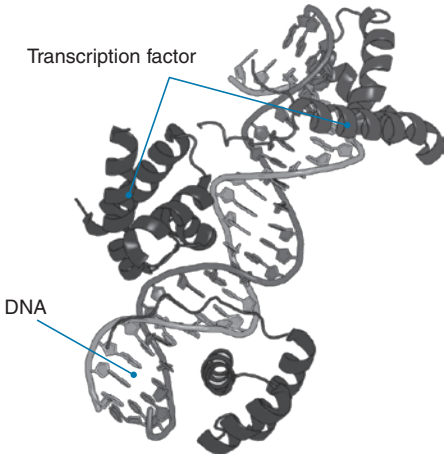
ISBN:978-1-927173-97-8

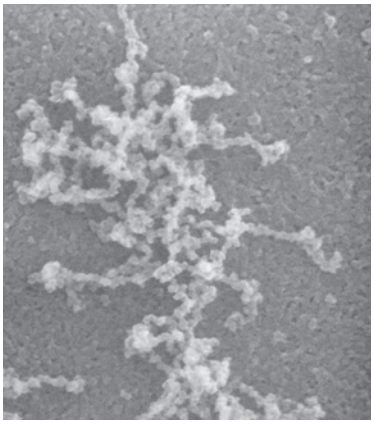
LINK 112 LINK 156 KNOW

167 Controlling Gene Expression

Key Idea: Gene expression is tightly regulated. It begins when RNA polymerase attaches to the promoter region of a gene. All the cells in your body contain identical copies of your genetic instructions. Yet these cells appear very different (e.g. muscle, nerve, and epithelial cells have little in common). These morphological differences reflect profound differences in the expression of genes during the cell's development. For example, muscle cells express the genes for the proteins that make up the contractile elements of the muscle fibre. This diversity of cell structure and function reflects the precise control over the time, location, and extent of expression of a huge variety of genes.

The physical state of the DNA in or near a gene is important in helping to control whether the gene is even available for transcription. When the **heterochromatin** is condensed, the transcription proteins cannot reach the DNA and the gene is not expressed. To be transcribed, a gene must first be unpacked from its condensed state. Once unpacked, control of gene expression involves the interaction of **transcription factors** (shown attached to the DNA molecule right) with DNA sequences that control the specific gene. Initiation of transcription is the most important and universally used control point in gene expression.



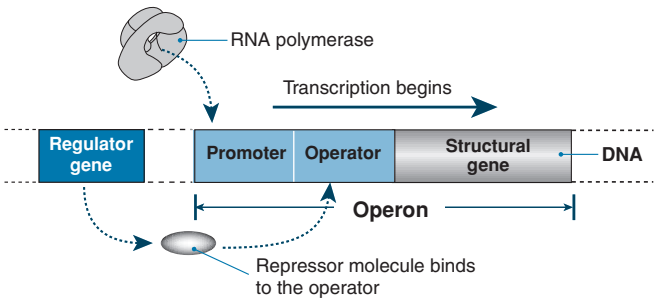


Unravelled mRNA after transcription.

Before transcription can take place, RNA polymerase must attached to the **promoter** region of the DNA. The promoter is upstream of the DNA to be transcribed. The process by which RNA polymerase binds to the promoter is different in prokaryotes and eukaryotes (below).

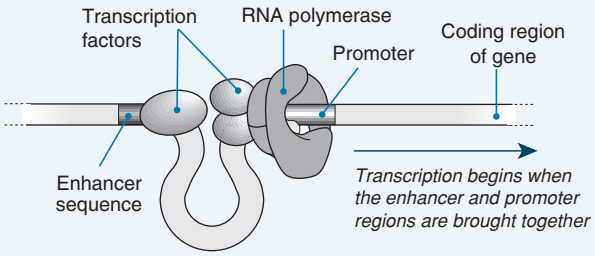
Control of Gene Expression in Prokaryotes

In **prokaryotes**, the RNA polymerase and associated proteins bind directly to the promoter region. The promoter is normally very close to the DNA region to be transcribed. Transcription of the structural gene is controlled by a **regulator** gene, which produces a repressor molecule that may bind to the operator and block transcription. The promoter, operator, and DNA to be transcribed are called an **operon**.



Control of Gene Expression in Eukaryotes

Eukaryote genes do not exist as operons. In **eukaryotes**, several **transcription factors** are required to bind the RNA polymerase to the promoter (the RNA polymerase cannot bind directly). Some of these transcription factors may also bind to the **enhancer** region which may be quite distant from the promoter. The transcription factors cause the promoter and enhancer to come together, which initiates transcription.



1. (a) How is transcription initiated in prokaryotes? _____

(b) How is transcription initiated in eukaryotes? _____

2. What is the role of the promoter? _____

KNOW LINK 195 LINK 122 WEB 167

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204 Mechanism of Natural Selection

Key Idea: Natural selection is the evolutionary mechanism by which organisms that are better adapted to their environment survive to produce a greater number of offspring.

Evolution is the change in inherited characteristics in a population over generations. Evolution is the consequence of interaction between four factors: (1) The potential for populations to increase in numbers, (2) Genetic variation as a result of mutation and sexual reproduction, (3) competition for resources, and (4) proliferation of individuals with better survival and reproduction.

Natural selection is the term for the mechanism by which better adapted organisms survive to produce a greater number of viable offspring. This has the effect of increasing their proportion in the population so that they become more common. This is the basis of Darwin's theory of evolution by natural selection.

We can demonstrate the basic principles of evolution using the analogy of a 'population' of M&M's candy.

In a bag of M&M's, there are many colours, which represents the variation in a population. As you and a friend eat through the bag of candy, you both leave the blue ones, which you both dislike, and return them to bag.

The blue candy becomes more common...

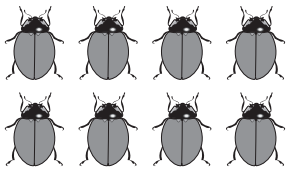
Eventually, you are left with a bag of blue M&M's. Your selective preference for the other colours changed the make-up of the M&M's population. This is the basic principle of selection that drives evolution in natural populations.

Darwin's Theory of Evolution by Natural Selection

Darwin's theory of evolution by natural selection is outlined below. It is widely accepted by the scientific community today and is one of founding principles of modern science.

Overproduction

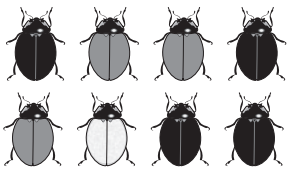
Populations produce too many young: many must die



Populations generally produce more offspring than are needed to replace the parents. Natural populations normally maintain constant numbers. A certain number will die without reproducing.

Variation

Individuals show variation: some variations more favourable than others



Individuals in a population have different phenotypes and therefore, genotypes. Some traits are better suited to the environment, and individuals with these have better survival and reproductive success.

Natural Selection

Natural selection favours the individuals best suited to the environment at the time

Individuals in the population compete for limited resources. Those with favourable variations will be more likely to survive. Relatively more of those without favourable variations will die.

Inherited

Variations are inherited:
the best suited variants leave more offspring

The variations (both favourable and unfavourable) are passed on to offspring. Each generation will contain proportionally more descendants of individuals with favourable characters.

1. Identify the four factors that interact to bring about evolution in populations: _____

_____

_____

_____

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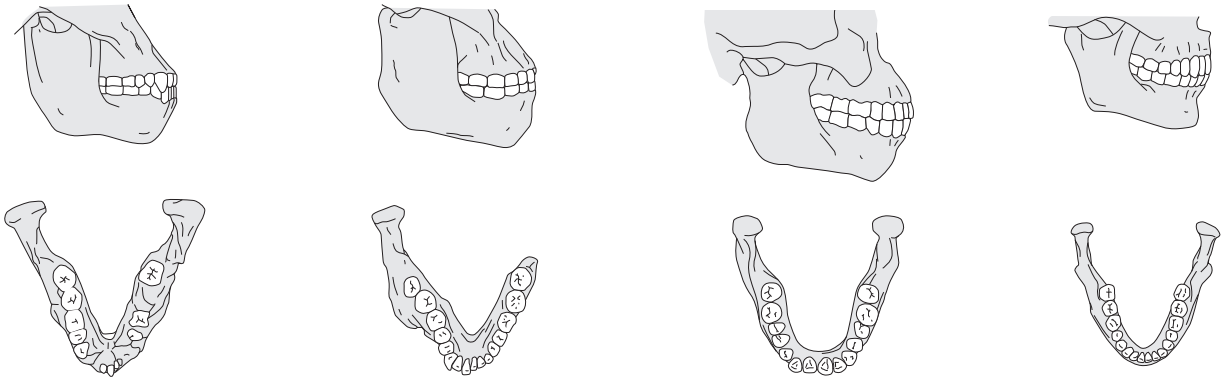
LINK 209 LINK 208 LINK 206 WEB 204 KNOW

259 Trends in Dentition

Key Idea: Changes in dentition (the type, number, and arrangement of teeth) and jaw structure of our hominin ancestors can reveal information about our evolution.

During early hominin evolution teeth (especially the molars) and jaws tended to be large. The paranthropines are the extreme example of this trend. Their diet of coarse vegetation required very large and powerful jaws and molars. During the course of hominin evolution, there was a general trend for a reduction in the size of the teeth tooth and jaw. This was a likely consequence of including a greater proportion of cooked foods, which required less chewing, in the diet. The teeth of modern humans are relatively small and generalised, reflecting an omnivorous diet of mainly processed (e.g. cooked) foods.

Early Hominins → **Late Hominins**



Australopithecus afarensis

- Relatively large canine teeth
- Relatively large jaw
- V-shaped dental arcade
- Thin tooth enamel
- Diet probably consisted of fruits with some tougher material

Australopithecus africanus

- Reduced canine teeth
- Large molars
- Dental arcade intermediate between *A. afarensis* and *H. sapiens*
- Thick tooth enamel
- Diet probably included vegetable matter, nuts, seeds, insects, and eggs

Homo erectus

- Thick jaw bones
- No chin
- Relatively large molars
- Parabolic dental arcade
- Thick tooth enamel
- Diet probably included vegetable material and a large proportion of meat

Homo sapiens

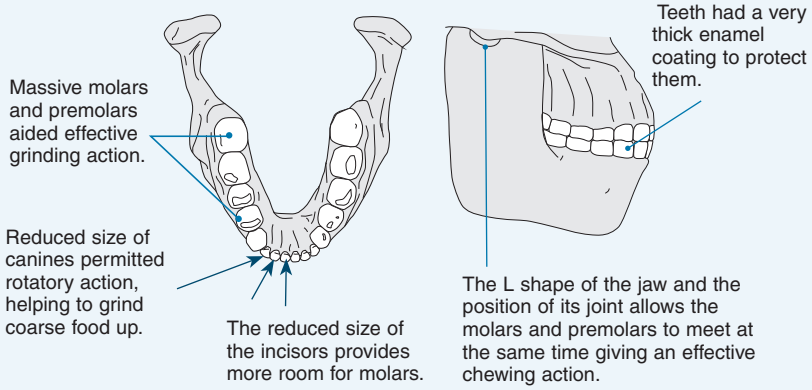
- Shortened jaw, allows large bite force to be generated with little effort
- Chin reinforces jaw, but leaves room for tongue muscles
- Thick tooth enamel
- Small molars adapted to chewing cooked and soft food
- Parabolic dental arcade

Dental formulae all follow: I-2, C-1, P-2, M-3

In many primates, the canine teeth are used in behavioural and social interactions, especially in species which show marked sexual dimorphism. Threat gestures, such as yawning (above), help maintain social order.

Adaptations to a Coarse Diet

Paranthropus boisei had jaws and teeth adapted to a diet of coarse vegetation and hard seeds. Their jaws produced a massive bite force of 2161 Newtons, which helped to break food up.



1. Describe the general trend in the evolution of hominin teeth: _____

_____

_____

_____

2. What is one possible purpose of the chin in modern humans? _____

_____

_____

KNOW LINK 254 LINK 255

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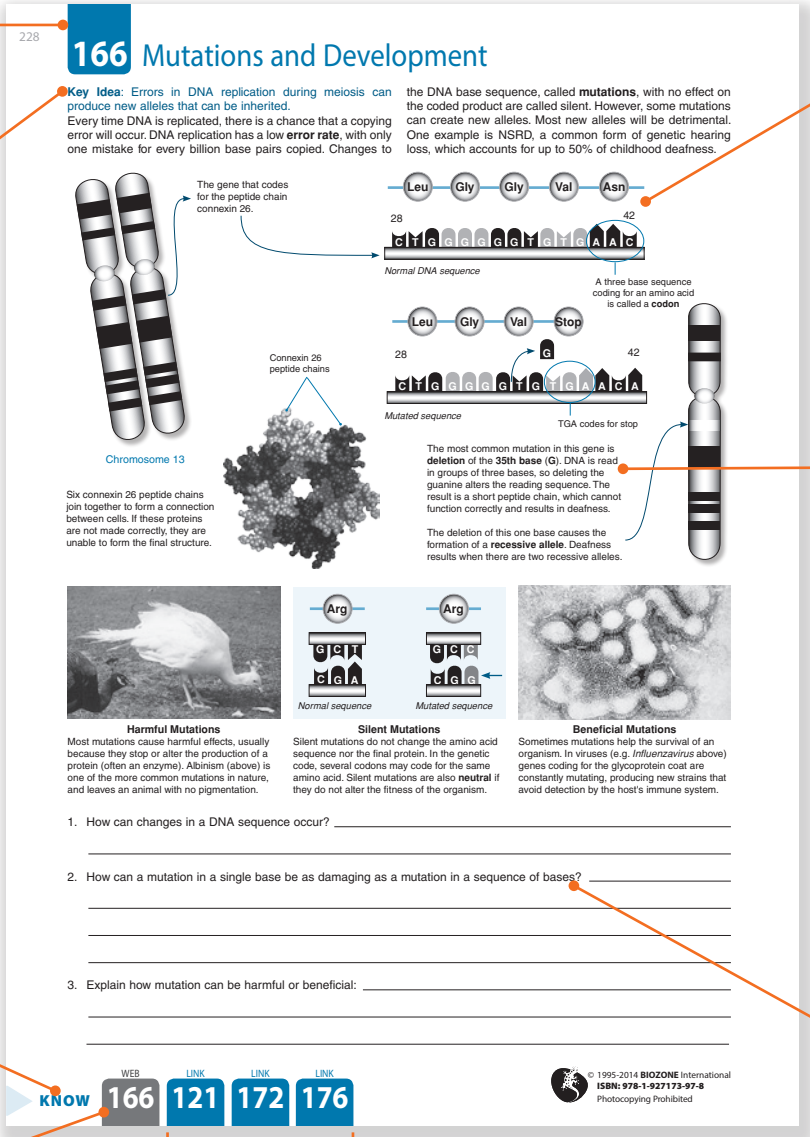
PAGE **FEATURES**

Activity number
Activities are numbered to make navigation through the workbook easier.

Key idea
Each activity has a key idea summarising its primary focus. The key idea helps students to understand the message of the page.



Activity codes
Page codes indicate the nature of the activity (e.g. KNOW indicates knowledge or basic understanding). Other codes indicate a focus on pratical skills, data handling, vocabulary, or comprehension. Activities for reference or assessment are also identified.

Web codes
Weblinks refer to an external URL supporting the material in this activity.

Link codes
Make it easy for students to locate related activities elsewhere in the workbook.

Visual impact
Large annotated diagrams explain the main idea of the activity, supporting and reinforcing the text based content.

Easy to understand content
The content has be written in language that students can easily understand.

The content is presented in logically organised blocks, making it easier for students to access and engage with the information.

Direct questioning style
The questions are designed to help students consolidate their understanding of biological processes, principles, and vocabulary. The question style is direct, making the message clear.

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