BIOLOGY

LEVELS OF LIFE

BRIAN LECORNU TONY DIERCKS

Contents

Distinguish between coding (gene) and template strands of DNA.

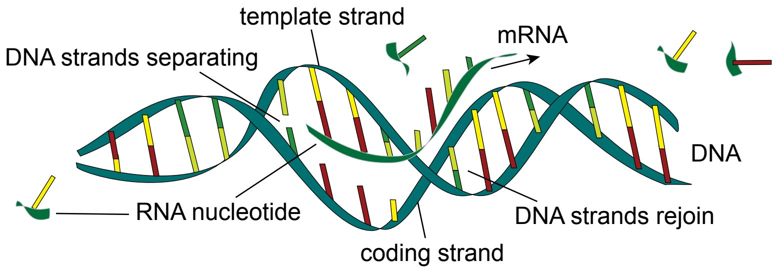


Figure 2.8 Transcription in the nucleus

Recognise that DNA strands are directional and are read 5′ to 3.

By convention, humans read DNA and RNA in the 5′ to 3′ direction. Also, DNA and RNA are always synthesised in the 5′ to 3′ direction. However, this means that the enzymes involved (DNA polymerase in DNA replication and RNA polymerase in transcription) must read the template DNA in the 3′ to 5′ direction. Note that ribosomes read mRNA in the 5′ to 3′ direction during translation.

On a chromosome, different genes may not be on the same strand of the DNA. What is it that determines which strand of the DNA will be copied? The start codon for copying the DNA is the triplet TAC, which also codes for the amino acid methionine. The DNA triplet TAC indicates where the gene begins, and all polypeptide chains begin with methionine. The two strands of the DNA run in opposite directions, so for genes on one strand, the enzyme RNA polymerase will start at a TAC and travel in one direction. On the other DNA strand, the RNA polymerase will start at a TAC and travel in the opposite direction.

Describe the relationship between DNA codons, RNA codons, anticodons, and amino acids.

Translation: From Nucleic Acid to Protein

The language of nucleotide is now converted to a language of amino acids in a process aptly named **translation**. A protein is made up of a chain of amino acids joined together. The sequence of amino acids defines the function of a particular protein. Some proteins will be structural and become part of cell membranes, while other proteins will be enzymes and thus direct the metabolism of the cell. One way or another, the proteins that a cell produces will have a profound impact on the structure and function of the cell, so it is essential that these proteins are synthesised correctly. When it comes to translation, accuracy is the name of the game.

The messenger RNA, carrying the coded instructions, attaches to a **ribosome**. Ribosomes are themselves made of RNA and protein. The RNA in ribosomes is a special type, produced in a special region of the nucleus called the **nucleolus**, and it is called

DNA IS DIRECTIONAL

tinyurl.com/44s3du3u

ANTIBIOTICS AND PROTEIN SYNTHESIS

Many antibiotics, chemicals that are anti-bacterial, work by inhibiting a step in protein synthesis in bacteria. See Chapter 11 for more information.

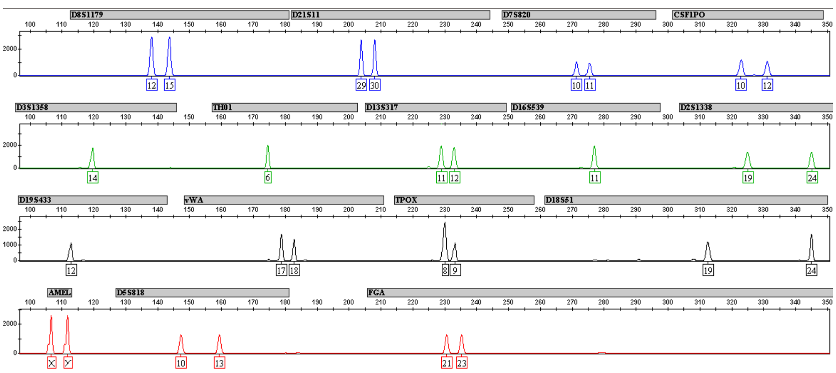
PEPTIDES, POLYPEPTIDES AND PROTEINS differ in their size and complexity - see glossary.

the mapping of the human genome relied on the use of restriction fragment length polymorphism (RFLP) techniques. Palaeontologists have even been able to study the tiny amounts of DNA left in fossils using PCR. Their results have enabled them to identify and classify ancient, long-extinct organisms, as DNA is surprisingly stable. The oldest DNA that has been analysed has lasted almost a million years.

The results of electrophoresis can be used to construct DNA profiles. They may be displayed in an electropherogram or in a table of data.

Interpret electropherograms and tables of data that illustrate DNA profiles.

Fluorescently tagged primers are used in the PCR process to amplify the STR regions of the DNA collected. When this amplified DNA is placed into a capillary electrophoresis tube, the smaller STR fragments will move faster. Each STR fragment is detected as it passes a laser beam at the end of the capillary tube. The result is displayed as a series of (paired) peaks on a graph called an **electropherogram** (see Fig. 5.9)



Locus	Chromosome	STR	Allele values
D8S1179	8	TCTA	12,15
D21S11	21	TCTA	29,30
D7S820	7	GATA	10,11
CSF1PO	5	AGAT	10,12
D3S1358	3	TCTA	14,14
TH01	11	AATG	6,6
D13S317	13	TATC	11,12
D16S539	16	AGAT	11,11
D2S1338	2	TGCC	19,24
D19S433	19	AAGG	12,12
VWA	12	TCTA	17,18
TPOX	2	AATG	8,9
D18S51	18	AGAA	19,24
Amelogenin	X; Y		X,Y
D5S818	5	AGAT	10,13
FGA	4	TTTC	21,23

Fig. 5.9 A DNA profile represented by a matching electropherogram and table of data

DNA FINGERPRINTS AND PROFILES

tinyurl.com/ydbld8tw

RFLP RESTRICTION FRAGMENT LENGTH POLYMORPHISM

At certain sites on DNA there are sections which have repetitive patterns. The length of these patterns varies from person to person- termed polymorphism. Specific restriction enzymes are used to cut the DNA at these sites. The cut lengths of DNA, called Variable Number Tandem Repeats (VNTR), from different DNA samples, can be compared by electrophoresis. The technique, called DNA fingerprinting, was invented by Sir Alec Jeffreys in 1984 and was the first of its kind to be used in forensic science. It has now largely been replaced by SNP and STR analysis.

DNA DATABASE

Since 2017, there have been 5 more loci added to the 16 used for the Combined DNA Index System (CODIS). This system has been devloped in collaboration with the FBI in the USA, and European agencies.

location. Gene editing has now become fast, simple, and inexpensive. The technique can also be used in live cells to edit genes, and to switch them on and off. (See Fig. 6.8 and Fig. 6.9) The CRISPR system can be used in any type of cell, including human cells. It is likely that genetic diseases may be treated using the CRISPR system to edit faulty genes. Even cancers may one day be cured by the appropriate use of this technology.

THE DISCOVERY OF CRISPR

This is an excellent example of how scientific discoveries often take many years to develop, and involve research in laboratories around the world. Sometimes, instead of collaboration being evident, there is 'competition', and there can be disputes that result in legal action to determine who made the discovery. The QR code and URL in the side bar provides an interesting account of this in the case of CRISPR-Cas9.

The first organisms to be modified using CRISPR-Cas9 technology were mushrooms in 2015. A small number of bases in the gene that codes for an enzyme that causes browning in the mushrooms was deleted, keeping mushrooms fresher longer.

Other techniques that have been used to edit genes include zinc-finger nuclease (ZFN) and transcription activator-like effector nuclease (TALEN).

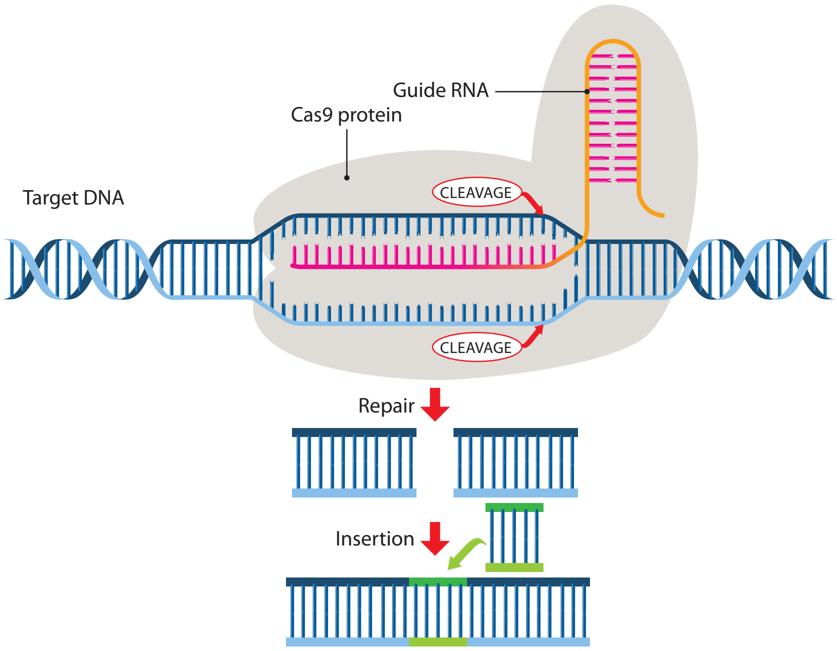


Fig 6.9 CRISPR-Cas9

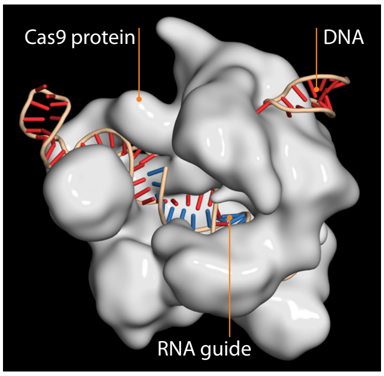


Fig 6.8 CRISPR-Cas9
Cas9 protein - white,
DNA - red nucleotides
RNA guide - blue nucleotides

THE DISCOVERY OF CRISPR

tinyurl.com/hwxvcqf

CRISPR

tinyurl.com/1t35o5v

CRISPR GENE EDITING

tinyurl.com/y8sr8q24

SHERLOCK

SHERLOCK is a new CRISPR system that uses Cas13a which recognises RNA instead of DNA. This may be used to diagnose certain diseases.

NONCODING DNA AND CRISPR

tinyurl.com/y5988u9w

As we shall see in Chapter 10, the fluid mosaic model allows an elegant explanation of the mechanisms by which substances move through the membrane, and hence, into and out of cells. The different carbohydrates on the proteins act as receptors and this explains how cells are able to recognise one another. As the term 'fluid' suggests, the membrane is not static, but is a dynamic living structure.

When we look at cells we find that they can be one of two basic forms.

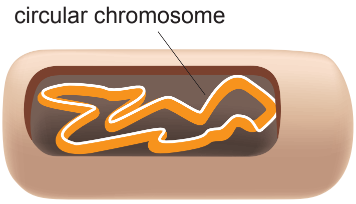


Fig. 7.7 Circular chromosome in a bacterial cell

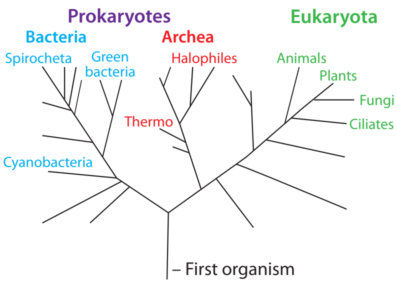


Fig. 7.8 Phylogenetic Tree of Life

ARCHAEA

Archaea are prokaryotic unicellular organisms that are more similar to eukaryotes than they are to bacteria. Their cell walls and membranes are different in structure from those of bacteria.

The major types of cell are
- prokaryotic
- eukaryotic.

Compare prokaryotic and eukaryotic cells with respect to their:
- size
- internal organisation
- shape and location of chromosomes

Prokaryotic cells

Prokaryotic cells are very small and have their genetic material present as a circular chromosome of DNA that is not separated from the rest of the cell. (See Fig. 7.7) **Bacteria** and **archaea** (see textbox) are prokaryotic, and all other cells are eukaryotic. (See Fig. 7.8)

Eukaryotic cells – plants, animals, fungi, protists

The genetic material of **eukaryotic** cells consists of DNA associated with proteins (histones) to form linear chromosomes. These chromosomes are separated from the cytoplasm of the cell by a double-membrane nuclear envelope, giving rise to a structure called a **nucleus**. (See Fig. 7.9) Thus, a major difference between prokaryotic and eukaryotic cells is the presence of a nucleus in one but not the other.

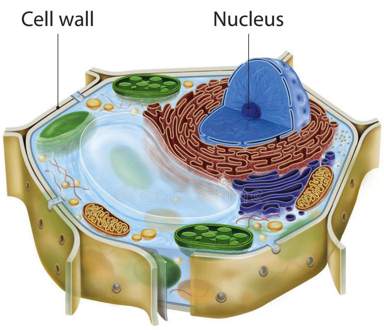


Fig. 7.9 A eukaryotic (plant) cell

There are other differences as well. Eukaryotic cells have a more complex internal organisation than prokaryotic cells. Eukaryotic cells contain membrane-bound organelles that prokaryotic cells lack, and are therefore 'compartmentalised'. The term **organelle** is used to describe discrete structural bodies within the cell such as the nucleus, mitochondrion and ribosome. Ribosomes do not have a membrane and the ribosomes of prokaryotic cells are smaller than those of eukaryotic cells.

In addition to their cell membrane, bacteria have an outer cell wall made of peptidoglycan. This compound is made up of

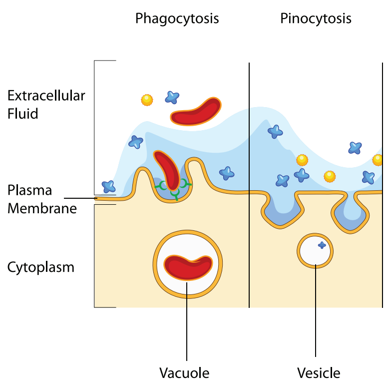


Fig. 8.15 Endocytosis

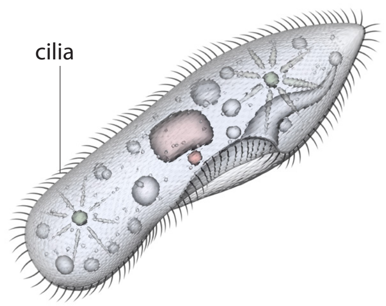


Fig. 8.16 *Paramecium* with cilia

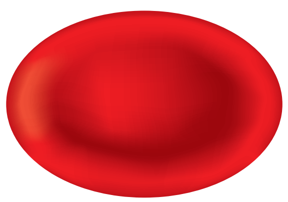


Fig. 8.17 A human red blood cell

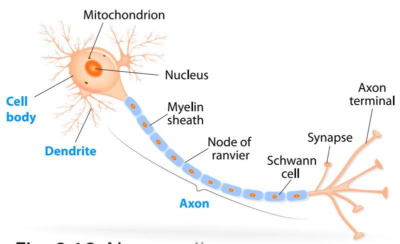


Fig. 8.18 Nerve cell

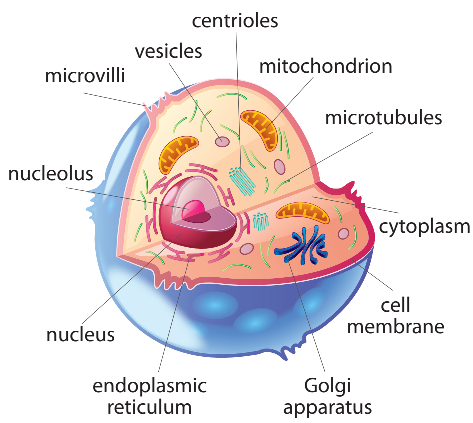


Fig. 8.19 Cell with microvilli

The main functions of the cytoskeleton are:

- to give cells their shape
- to be involved in cell movement
- to hold organelles in place
- to strengthen cells.

Microfilaments, made of the globular protein actin, are involved in intracellular movement like cytoplasmic streaming, chloroplast orientation, the pinching in of the cell membrane to form daughter cells after cell division, and the formation of a food vacuole by the process of phagocytosis. (See Fig. 8.15) The contraction of muscle is due to one group of microfilaments interacting with another. Actin proteins are also found in some prokaryotes.

Microtubules, made of the protein tubulin, are an essential part of the flagella or cilia, fine hair-like projections found on many cell membranes. The coordinated beating of these structures causes fluid movement, so that either the cell moves or fluid moves past the cell. A unicellular organism like a *Paramecium* uses cilia to move around its environment (See Fig. 8.16), while epithelial cells in the airways of our lungs use cilia to move mucus out of the lungs.

Intermediate filaments are made up of strong fibrous proteins and they are found in cells, such as skin cells, that are subject to wear and tear. The function of the intermediate filaments is to strengthen these cells and their tissues.

Cytoskeleton examples

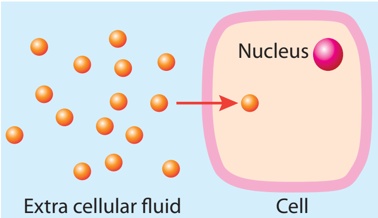
A human red blood cell is formed into a bi-concave shape, rather than a sphere, by its cytoskeleton, and this gives it a high surface area to volume ratio, suitable for transferring oxygen by diffusion. (See Fig. 8.17) A nerve cell, with its very long axon, is another example of a cell shape that would be impossible without a cytoskeleton. (See Fig. 8.18)

The cytoskeleton also enables some cells to have highly specialised surfaces. Bundles of actin filaments support microvilli (See Fig. 8.19) on cells such as intestinal epithelium, kidney tubule epithelium, and the hair cells of the inner ear.

The organelles in the cell are not only moved by the cytoskeleton, but they are held in place by it. The chloroplasts in plant cells are held near the surface of the cell with the correct orientation to receive maximum light. When a killer T-cell of our immune system moves alongside an infected cell to destroy it, the Golgi apparatus is held in place over the infected cell by the cytoskeleton.

Movement within a cell is made possible by the cytoskeleton. During cell division, a specialised microtubule structure called the **spindle apparatus** is formed to facilitate the movement of

Diffusion, facilitated diffusion, and osmosis are passive processes.



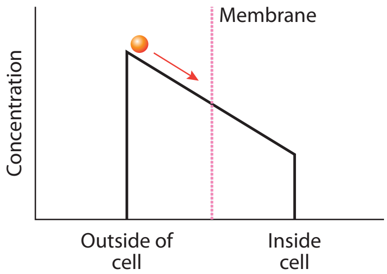


Fig. 10.5 Downhill - with the concentration gradient

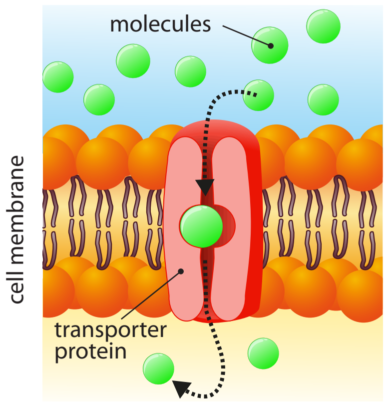


Fig. 10.6 Facilitated diffusion

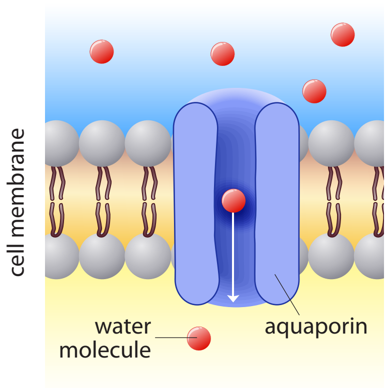


Fig. 10.7 An aquaporin - osmosis

Diffusion

All particles (atoms and molecules) have kinetic, or heat, energy and as a result of this they are in constant random motion. Due to this random motion there is a tendency for the particles of a substance to spread out, or diffuse, until they take up all the available space. This phenomenon is likely to be more pronounced in gases and liquids than in solids, as the particles in solids tend to be held together more tightly. This overall movement occurs due to the random movement of particles, and it will continue until the substance is equally dispersed throughout the container. We say that equilibrium is reached when this occurs. (See Fig. 10.4) Note that when equilibrium is reached the movement of particles does not cease, even though diffusion will no longer be occurring. The number of particles moving in one particular direction will then be balanced by the number moving in the opposite direction. Under these conditions the net movement is zero, and there is no concentration gradient.

A useful definition of **diffusion** is *the overall movement of a substance in a fluid from a region of high concentration of the substance towards regions of lower concentration of the substance.* The particles are moving with or following the concentration gradient. (see Fig. 10.5)

The relevance of diffusion for cells is, provided the cell membrane is permeable to a particular substance, that substance will diffuse across the membrane if a concentration gradient exists. Good examples of this include the diffusion of oxygen into cells and the diffusion of carbon dioxide out of cells. In both cases the concentration gradient is maintained by the activities of the cell. Cells continuously use up oxygen and produce carbon dioxide as a result of respiration. Diffusion is a passive process because it does not require any expenditure of energy by the cell. It occurs even in dead cells and in nonliving systems.

Facilitated diffusion

An example of the membrane's ability to be selective is that it allows a fairly large molecule like glucose to diffuse through, while preventing the passage of other, smaller molecules. Transporter proteins in the membrane bind to certain ions or molecules and assist them across the membrane. (see fig.10.6) Other ions or molecules, even though they are smaller, have no specific protein to help them, and so cannot move across. When transport proteins assist the movement of substances such as glucose, amino acids, and ions along the concentration gradient, from a region of high concentration towards a region of lower concentration, the process is known as facilitated diffusion. No energy is required for this passive process.

Describe the structure of a nerve pathway from receptor to effector.

A **receptor** detects a **stimulus** and this triggers a **nerve impulse** which travels along a **sensory neuron** towards the **spinal cord** or brain in the CNS. The impulse is transmitted along nerve fibres in the spinal cord to the brain. The information is processed by the brain, which sends a nerve impulse down the spinal cord along a **motor neuron**. The motor neuron carries a nerve impulse to an **effector**, either a muscle or gland, and this results in a **response**. It is interesting to note that nerve fibres (axons) in the human body may be more than a metre long! (See Fig. 17.6)

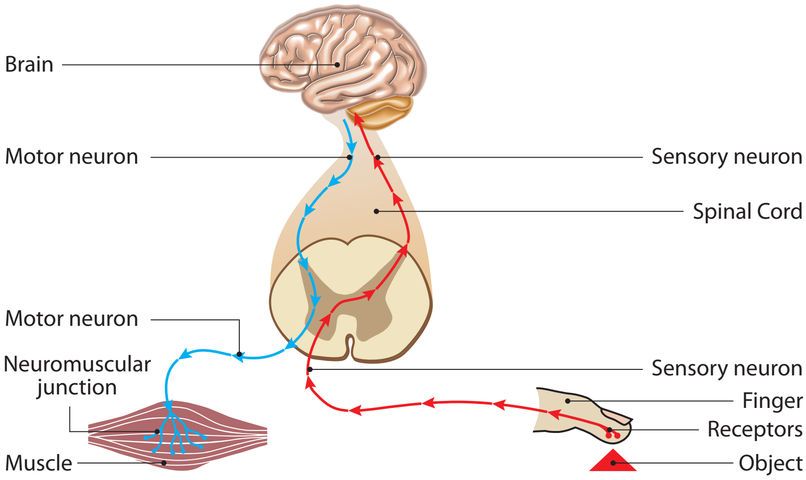


Fig. 17.6 Impulse along the spinal cord

An important exception to the nerve pathway described above is a reflex response that does not involve the brain. Details of the pathway of a reflex response are included later in this chapter.

Describe the role of synapses and neurotransmitters.

As we have seen, a nerve pathway is made up of a series of neurons that transmit an impulse from one neuron to the next. There is a junction, called a **synapse**, with a gap - called a **synaptic cleft** - between the axon of one neuron and the dendrite of the next. Transmission across the gap is by a chemical called a **neurotransmitter** that is secreted from the axon terminal of the incoming neuron. (See Fig. 17.7)

There are many different neurotransmitters, the main one being **acetylcholine**. Others include dopamine, serotonin, noradrenaline, and adrenaline. These are called *excitatory* neurotransmitters because they stimulate the next neuron in the pathway. Other neurotransmitters, such as GABA, and even the amino acid glycine, are called *inhibitory* transmitters because they block the nerve impulse. In either case neurotransmitters act by combining with receptor molecules on the membrane of the receiving cell. As we know, this involves the neurotransmitter and receptor molecules having complementary shapes.

Some drugs act by mimicking neurotransmitters at synapses.

NEUROTOXINS

Many snake venoms act as neurotoxins and cause paralysis. The production of snake antivenom by traditional means is time consuming and expensive. It involves 'milking' venom from dangerous snakes and the yields are usually very low. New technologies using recombinant DNA or nanoparticles promise more efficient methods of production. To achieve this, funding is needed from science, business, and government.

SYNTHETIC SNAKE ANTIVENOM

tinyurl.com/z7j7v5m

tinyurl.com/z4xpr5o

CSIRO SNAKE ANTIVENOM FOR DOGS

tinyurl.com/yam2v8mx

USE OF HORMONES IN MILK PRODUCTION

A hormone called recombinant bovine somatotrophin (rBST) that increases milk yield in dairy cattle is banned in some countries, including Australia and New Zealand, but is used elsewhere, including the USA. The ban has important economic implications for Australia and New Zealand, as they are major international suppliers of dairy products, and the risks of rBST are still controversial.

The role of the hypothalamus as a 'bridge' between the nervous and endocrine systems

The hypothalamus in the brain is part of the central nervous system and it provides a 'bridge' between the nervous system and endocrine system. It receives signals via afferent nerves, sends nerve impulses via autonomic nerves, and secretes hormones and hormone-like substances that control the secretion of hormones by the pituitary gland. The hormones ADH and oxytocin are produced by the hypothalamus and travel to the posterior pituitary via a 'neural tube', where they are stored and subsequently released into the blood.

The hypothalamus also produces stimulating and inhibiting hormones that travel via the blood to the anterior pituitary. An example is TRH, which stimulates the production of TSH. (See Fig. 18.10) As part of negative feedback in the control of body temperature, the hypothalamus also responds to changes in the level of thyroxine and TSH in the blood.

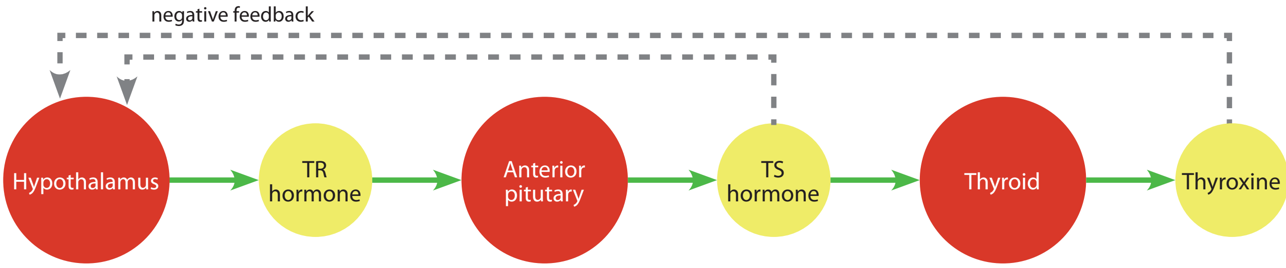


Fig. 18.10 Hormones from the hypothalamus

Study Questions

1. Explain, using an example, the meaning of the terms hormone, endocrine gland, target cell, and target organ.
2. The endocrine system is made up of the endocrine glands that secrete hormones.
   For the hormones, adrenaline, thyroxine, antidiuretic hormone, glucagon, insulin and aldersterone, state which gland secretes them, their target, and their effect.
3. How does a hormone's shape compare to the shape of its corresponding receptor?
4. Explain the difference between the receptor for a lipid soluble steroid hormone and the receptor for a water soluble protein hormone using labelled diagrams.
5. Endocrine glandss have to be stimulated to secrete their hormones by either nerves or other hormones. Give specific examples of each method.
6. Outline the role of adrenaline in the 'flight or fight' response.
7. Describe the role of the thyroid stimulating hormone in the production of thyroxine?
8. What functions do the nervous system and the endocrine system have in common and what are the main differences?

Glucose and glycogen are carbohydrates. Glucose molecules are single sugar units called monosaccharides. Glycogen is made up of many glucose units joined together and it is called a polysaccharide. (see Fig. 19.9)

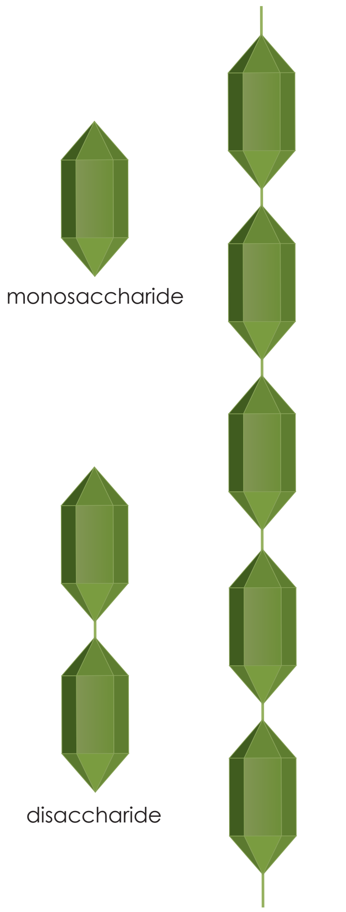


Fig. 19.9 Carbohydrates

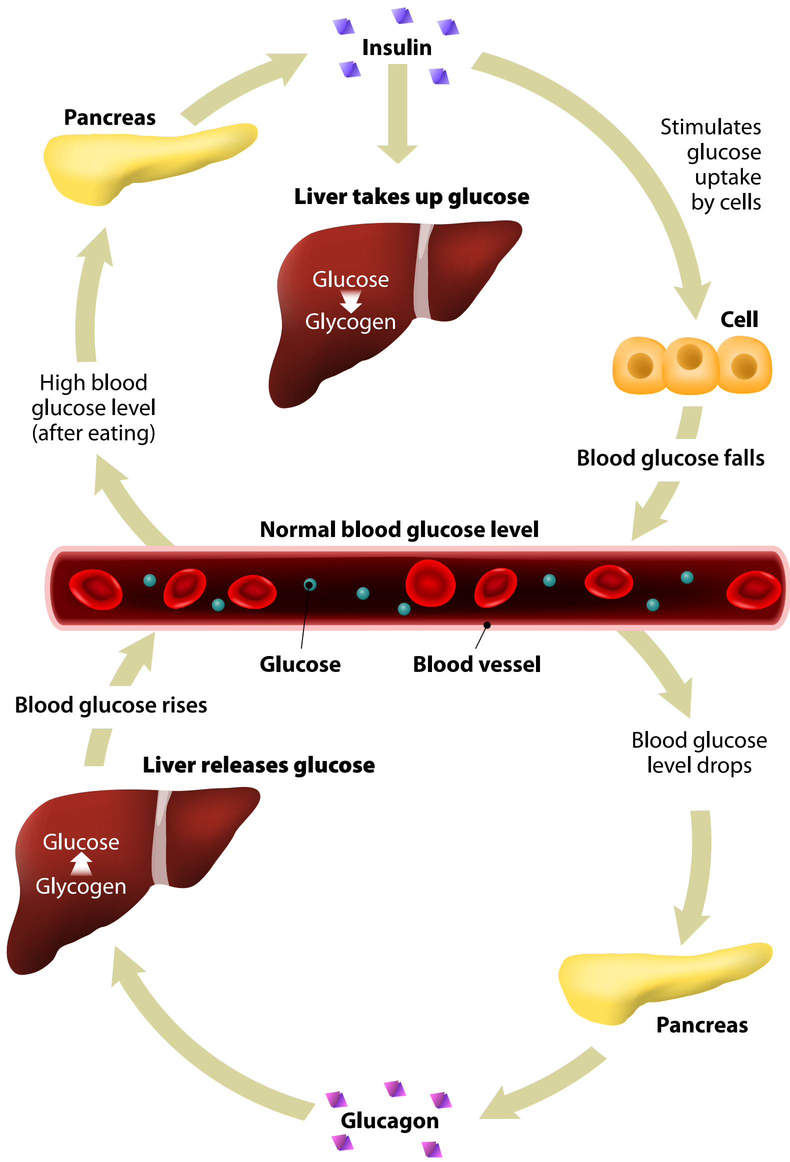


Fig. 19.8 Regulation of blood glucose

Describe how diabetes mellitus can result from a hormonal imbalance.

The term diabetes refers to the over production of urine and is usually due to the inability to maintain blood sugar level in the normal range.

Type 1 diabetes results from the inability to produce insulin due to an auto-immune disease that destroys insulin-producing cells of the pancreas.

Type 2 diabetes results from the body becoming resistant to insulin and/or being unable to make enough insulin. The current treatment for Type 2 is to control sugar intake by adopting a low calorie diet. Type A insullin resistance is discussed on page 24. There are trials of medicine that improve the body's sensitivity to insulin.

In Chapter 5 we outlined the production of human insulin by bacteria, using genetic engineering.

22 Evidence for Evolution

Fig. 22.1 Flinders Ranges Fossil

Evolution

If we consider the current species on Earth and examine the fossil evidence of previous populations carefully, it becomes obvious that there have been significant changes. These changes have taken place gradually over a very long period of time. Biologists use the term **evolution** to describe the changes that have occurred to life on Earth. This process of evolution is widely misunderstood, but it merely explains that the first forms of life were simple and few in number, and that changes have occurred giving rise to an incredible range of complex life forms today.

Mutation is a permanent change in the sequence of DNA nucleotides and is the ultimate source of genetic variation in a species.

Changes in the genetic material occur all the time and these changes can arise either spontaneously, or be induced. Such changes are called **mutations**.

Copying errors when DNA is replicated is an example of a spontaneous mutation. Cells do have a mechanism for correcting such errors, but even so, some may remain. Environmental factors, such as high energy radiation (e.g. X-rays and ultra-violet), mutagenic chemicals, and viruses can induce mutation in DNA. This is discussed in more detail in Chapter 4.

MOLECULAR CLOCK

tinyurl.com/y9mvveyv

Mutations accumulate over time. If the mutation rate is known, it can be used as a 'clock'.

Over billions of years the cumulative effect of these mutations has been to create a diversity of DNA molecules, and this is reflected in the diversity of life forms on Earth. If it were not for these mutations, there would have been no changes, and life on Earth today would be the same as it was at the very beginning.

Mutation rate varies from species to species. If the mutation rate is known it can be used as a 'clock'.

When life began, the DNA of the first organisms appears to have been in the form of a circular, double-stranded chromosome. As the chromosomes in these primitive cells became larger they broke up into several linear double strands, with several starting points along their length so they could be duplicated more quickly. DNA was

Glossary

0 - 9

2-naphthylamine
a chemical that causes cancer of the bladder

A

abiotic
a non-living component of the environment, such as rainfall

accuracy
the degree to which a measurement is close to the true value

acid rain
rain that contains dissolved pollutants, such as sulfur dioxide, thus making it acidic

acquired characteristic
obtained during a lifetime; not inherited

actin
a globular protein that forms microfilaments in cells

activation energy
the energy required to start a chemical reaction

active
requires the input of energy – not passive

active site
a region with a particular shape on the surface of an enzyme molecule into which a substrate molecule with a complementary shape will fit

active transport
the movement of a substance across a membrane against the concentration gradient, thus requiring input of energy

adaptation
any feature of an organism that enables it to survive and/or reproduce

adaptive radiation
a special case of divergent evolution in which there is a sudden emergence of new species from a common ancestor

adenine
a nitrogen base found in nucleic acids (A)

adenosine diphosphate
see ADP

adenosine triphosphate
see ATP

adipose tissue
connective tissue made up of adipose cells that are filled with lipid

ADP
adenosine diphosphate, a molecule of adenosine with two inorganic phosphate groups attached. Use to make ATP

adrenaline
a hormone released by the adrenal glands and nerve endings. The so-called "fight or flight" hormone

adrenal glands
glands located on top of the kidneys that release the hormone *adrenaline*

aerobic respiration
a chemical process using oxygen that occurs in many cells and involves the breakdown of glucose to carbon dioxide and water, releasing energy

afferent
conducting towards; see *efferent*

AIDS
acquired immune deficiency syndrome that may result from infection with HIV

alcohol fermentation
anaerobic respiration in plant cells and yeast that forms alcohol (ethanol) and carbon dioxide

allele
an alternative form of a gene for a particular characteristic – more recently also refers to variation among non-coding DNA sequences

allopatric speciation
the process of forming new species from a single population that becomes divided by geographical barriers

alveolus
air sac (in mammalian lungs)

Ames test
a process that uses bacteria to check chemicals for carcinogenic effects

amino acid
the subunit of proteins. Of the more than 80 naturally occurring amino acids, only 20 are found in proteins

amniocentesis
a test involving removal of amniotic fluid and accompanying foetal cells through the wall of the abdominal cavity

amniotic fluid
the fluid surrounding the foetus during development *in utero*

amoeba
an aquatic single-celled organism that feeds by phagocytosis

amylase
enzyme involved the digestion of starch to maltose (a disaccharide)

anaerobic respiration
a chemical process, not requiring oxygen, that occurs in some cells and involves the partial breakdown of a fuel such as glucose, releasing some energy. In animal cells the product is lactic acid, and in plant and yeast cells the products are ethanol and carbon dioxide

anaphase
the stage in mitotic cell division in which sister chromatids separate

anaphase 1
the stage in the first meiotic cell division in which homologous chromosomes separate

anaphase 2
the stage in the second meiotic cell division in which sister chromatids separate

antibiotic
a chemical that kills bacteria or prevents their growth

antibody
a specific protein molecule that combines with the antigen that caused its production

anticodon
the region composed of three nitrogen bases on a transfer RNA molecule that is complementary to the codon on messenger RNA

antidiuretic hormone (ADH)
a hormone produced by the hypothalamus and released via the posterior pituitary; it increases water reabsorption from the collecting ducts into the blood in the kidneys, reducing urine output (diuresis); ADH is also known as vasopressin

antigen
a substance that stimulates the production of specific antibodies. Usually a protein, carbohydrate, or glycoprotein
antigen-binding site
the site on an antibody molecule with a shape that is complementary to the antigen that stimulated its production
antigenic determinant
the region on an antigen molecule with a specific shape that is complementary to the shape of the antigen binding sites on the corresponding antibody molecule
aorta
the large artery that carries blood from the left ventricle of the heart
aquaporin
a channel protein that allows the movement of water across a membrane. The process is passive and is called *osmosis*
aquatic
relating to water
arteriole
small blood vessel between capillary network and artery
artery
vessel with muscular, elastic wall that transports blood away from the heart
asexual reproduction
the production of new individuals without the mixing of genetic material
atom
smallest unit with a particular chemical characteristic. An element consists of one kind of atom.
ATP
adenosine triphosphate, a cell's short-term energy storage compound
ATP cycle
the repeated formation and breakdown of ATP to transfer energy within a cell
autosomal
not sex-linked (nor X-linked)
autosome
a non-sex chromosome (i.e. not an X or Y chromosome in humans)
autotroph
an organism that is able to manufacture *all* of its complex organic compounds from simple inorganic substances
auxin
a plant hormone that stimulates growth
axon
the long process of a nerve cell that carries nerve impulses
axon terminal
nerve impulses travel along the axon of a neuron towards the axon terminal; the axon terminal secretes a neurotransmitter that triggers an impulse in the dendrites of the next neuron in the nerve pathway, or causes a response in an effector

B

bacteria
simple unicellular prokaryotic organisms; some cause disease
bacterial transformation
a process in which DNA is incorporated into bacteria; an example is the incorporation of recombinant plasmids into bacteria in genetic engineering
barbiturate
a chemical that has a depressant effect on the central nervous system
base triplet
see codon
basement membrane
a matrix of glycoprotein fibrils, on which epithelial cells sit
binary fission
the asexual reproduction of a prokaryotic cells involving splitting in two
biodiversity
the variety of organisms living in a region
biomass
the total mass of organic matter in a community, usually measured by dry weight
biosphere
that portion of the Earth that is inhabited by organisms
biotechnology
the use of living things or living systems to produce useful materials. Recently, this has focused on the manipulation of genetic material
biotic
the living component of an area
bivalent
paired homologous chromosomes during meiosis, consisting of four chromatids
bladder
a sac for the storage of fluid
bolus
ball of food mixed with saliva that is swallowed
Bowman's capsule
part of the nephron in the kidney
bronchiole
branch of bronchus in the lung that transports air to and from the alveoli
bronchus
one of two branches of the trachea in the lungs
budding
method of asexual reproduction in which a new individual forms on the parent and then breaks away

C

Calvin cycle
part of photosynthesis; also known as "dark reaction"
cancer
a disease due to the proliferation of mutant cells
capillary
microscopic blood vessel involved in exchange of materials between blood and tissues
carbohydrate
organic compound containing carbon, hydrogen, and oxygen. Mono-, di-, and polysaccharides (simple and complex sugars)
carbon monoxide
a poisonous gas formed by incomplete burning of materials containing carbon. It competes with oxygen for the sites on haemoglobin.
carcinogen
a cancer-causing substance
cardiac
of the heart
cardiovascular system
system comprising heart, blood, and blood vessels
carnivore
an animal that derives its energy and nutrition by eating other animals
carrier protein
a transport protein that binds to the substance it transports. Some carrier proteins are involved in *facilitated diffusion,* a passive process. Glucose transporter proteins (GLUTs) are examples. Other carrier proteins, called *protein pumps* are involved in *active transport,* requiring energy
carrying capacity
the maximum number of organisms that a habitat can support
Cas protein
a CRISPR associated protein that is an endonuclease; it can be 'programmed' with RNA to cut DNA at a specific site - an example is Cas9. Cas13a is an endonuclease protein that can be guided to cut RNA at a specific site (see SHERLOCK)

Index

BIOLOGY: LEVELS OF LIFE Australian Curriculum Edition

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