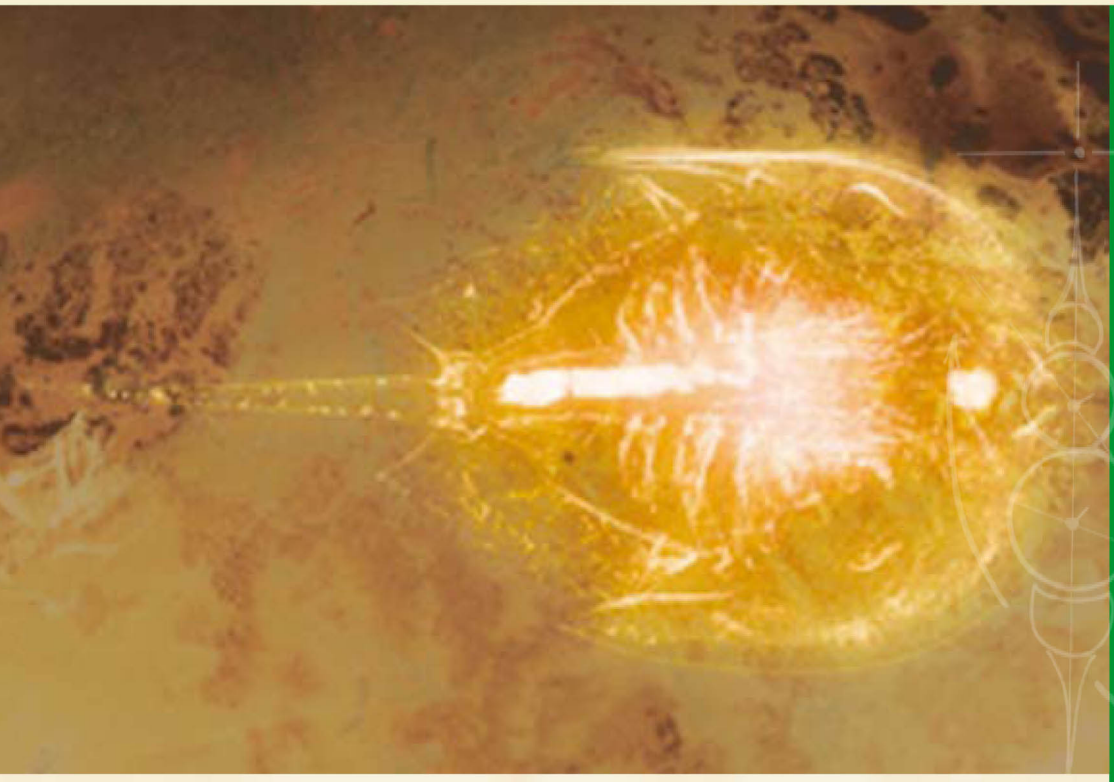
BIOLOGY



ANSWERS

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with
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Student CD included inside

3rd Edition

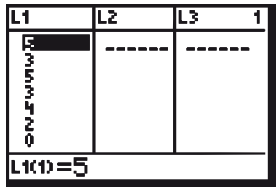
FOR USE WITH THE INTERNATIONAL BACCALAUREATE DIPLOMA PROGRAMME

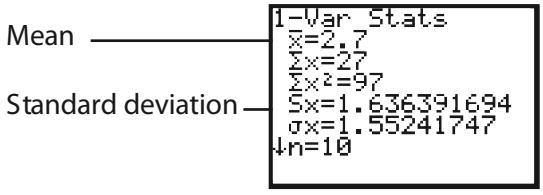
CHAPTER 1

1 The mean is determined by adding the data to obtain 27. The mean is now found by dividing by the number of items of data (10) to obtain a mean of 2.7.

Direct entry of the data into a graphic calculator (in this case a Texas TI-83) gives an immediate answer.

First use the STAT mode and enter the data as a list.





To calculate the standard deviation manually using the formula

$$\sqrt{\frac{\sum(x-\bar{x})^2}{n-1}},$$

we could use a table.

Number of eggs	$x-\bar{x}$	$(x-\bar{x})^2$
5	2.3	5.29
3	0.3	0.09
5	2.3	5.29
3	0.3	0.09
4	1.3	1.69
2	-0.7	0.49
0	-2.7	7.29
2	-0.7	0.49
1	-1.7	2.89
2	-0.7	0.49

The sum of the third column gives

$$\sum(x-\bar{x})^2$$

$$= 24.1$$

The sample standard deviation

$$= \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} = \sqrt{\frac{24.1}{10-1}} = 1.6363917$$

2 (i) The population means for drugs A and B are the same.
(ii) The population means for drugs A and B are different.
(iii) 3.899
(iv) 2.10
(v) Greater
(vi) Yes

CHAPTER 2

1B, 2C, 3D, 4A, 5C, 6B, 7B, 8C, 9A, 10B, 11A, 12B, 13D, 14A, 15B, 16A, 17B, 18A

19 The correct order is: atom, DNA double helix (thickness, length is much more), thickness of membrane, organelle, prokaryotic cell, eukaryotic cell

20 (a) The child has the larger surface area.
(b) dog: SA/V = 0.13/2 = 0.065
child: SA/V = 0.9/24 = 0.0375
the dog has a higher SA/V ratio than the child
(c) If the SA/V ratio is larger, the organism is likely to loose more heat so based on this, the dog would need more food per kg bodyweight than thechild. However, as the child is likely to be growing and the dog is fully grown, the child is likely to eat more. The level of activity may also be different which would affect the amount of food needed.

21 (a) Refer to Figure 215.
(b) Refer to Figure 222.
(c)

organelle	structure	function
rER	small structures, consisting of 2 subunits, each made of RNA and protein	proteins for use outside the cell are produced here
lysosome	membrane surrounding (hydrolytic) enzymes	intracellular digestion and autolysis
Golgi apparatus	stack of flattened, membrane bound sacs, forming an extensive network in the cell	intracellular transport, processing and packaging
mitochondrion	double membrane, inner membrane folded into cristae, surrounding matrix.	involved in the release of energy from organic molecules
nucleus	contains DNA in linear chromosomes, surrounded by nuclear envelope	controls the activity of the cell by transcribing certain genes and not others (see 3.5)

22 (a) Refer to Figure 233
The membrane is made of a phopholipid bilayer. This consists of a number of phosholipid molecule. Each phospholipid molecule is made of a polar/hydrophilic phosphate, attached to a central glycerol molecule which also has 2 nonpolar/hydrophobic lipid tails. In the phospholipid bilayer, the phosphate molecules are found on either side of the layer and the lipid tails are facing each other in the centre.
In between the phospholipid molecules, there are cholesterol molecules and proteins. Integral proteins are proteins which are mostly found in between the phospholipid molecules of the membrane and peripheral proteins are mostly found outside the phospholipid bilayer but interacting with the phosphate heads.

(b) the middle of the phospholipid bilayer is hydrophobic/non-polar which means that the part of the protein that is found in this area also needs to be non-polar. If it were polar, it would move through the phospholipid bilayer to find other polar molecules to make hydrogen bonds. This would obviously disrupt the structure of the membrane.

23

creation of two genetically identical nuclei	mitosis	telophase
biochemical reactions	interphase	
separation of sister chromatids	mitosis	anaphase
DNA replication	interphase	S-stage
chromosomes moving to the equator	mitosis	metaphase
protein synthesis	interphase	

24 Asexual reproduction, cloning, growth, repair. Mitosis, with meiosis, is also part of the process of producing gametes.

25 Volume is length x width x height so as the cell gets bigger, volume increases to the power 3. Surface area is length x width so surface area incrases to the power 2.
Rate of use of resources (food, oxygen) and the rate of heat and waste production (urea, carbon dioxide) are linked to the volume of the cell. Rate of exchange (of e.g. oxygen) is linked to the surface area. So the need for e.g. oxygen will increase faster than the ability to take it up.

26 real size x magnification = measured size
real size = measured size / magnificatio
$8 \times 10^{-3} / 400$
magnification 20×10^{-6}
the actual size of the nucleus is 20 micrometres.

Chapter 3

1D, 2C, 3B, 4A, 5D, 6A, 7D, 8A, 9A, 10A

11 Thermal properties: water needs a lot of energy to warm up and a lot of energy to go from solid to liquid or liquid to gas. This is because of the strong cohesion forces between molecules.
Water molecules have a negative and a positive side. This means that they are polar. There are hydrogen bonds (attraction forces) between the negative side of one molecule and the positive side of another which causes the cohesion forces between water molecules.
Water is a good solvent for polar molecules. Polar molecules can interact with water molecules in the same way that other water molecules do. Non-polar molecules do not interact with water molecules and therefore do not dissolve well.

12 (a) carbohydrates: carbon, hydrogen, oxygen
(b) lipids: carbon, hydrogen, oxygen
(c) proteins: carbon, hydrogen, oxygen, nitrogen

13 (a) carbohydrates: e.g. glucose - *see Figure 313*
(b) lipids: glycerol and fatty acids - *see Figure 317*
(c) proteins: amino acids - *see Figure 319*

14 The condensation reaction between monosaccharides is between two OH groups, forming water. This leaves one O in place which forms an oxygen bridge between the monosaccharides. The condensation reaction between two amino acids is between NH_2 of one amino acid and COOH of the other amino acid. The H of the NH_2 group combines with the OH of the COOH group, forming water and a peptide bond.

15 (a) Enzymes are proteins. Increasing the temperature changes the three dimensional shape of any protein, so also that of the active site of the enzyme. If the active site changes shape, then the substrate will no longer fit and the enzyme does not work anymore.
(b) Increasing substrate concentration will make it more likely that the active site of any enzyme has a substrate attached. Therefore the speed of the reaction will increase untill all active sites are filled with substrate at any time. Further

increasing the substrate concentration will not increase the rate of reaction.

(c) Denaturation occurs when the shape of the active site of the enzyme changes. The substrate no longer fits and the rate of the reaction becomes very low.

16 (a) covalent bond caused by a condensation reaction

(b) covalent bond caused by a condensation reaction

(c) hydrogen bonding caused by positive-negative attraction forces between either oxygen or nitrogen in one base and hydrogen in the other.

(d) covalent bonds are stronger because they involve sharing electrons.

(e) because A and T both form two Hydrogen bonds and C and G both form 3 Hydrogen bonds. Also, A and G are purines (have two rings) while C and T are pyrimidines (have one ring) and there is room for exactly three rings between the sides of the DNA ladder.

17 *Similarities*:
Both are nucleic acids, made of nucleotides. Nucleotides contain a pentose sugar, a phophate and an organic base.

Differences:
DNA has de-oxyribose, RNA has ribose.
DNA has thymine, RNA has uracil
DNA has two strands, RNA has one strand
DNA is usually in the shape of a double helix, RNA is not.

18 (a) light intensity, colour of the light, amount of carbon dioxide available, temperature.

(b) oxygen, ATP (and NADPH)

19 (a) ATP, NADH and pyruvate

(b) ATP, CO_2, ethanol, lactic acid, heat

20 It is done by attaching the enzyme lactase to a large molecule and then bringing it into contact with milk. Any lactose present will be broken down into glucose and galactose by the lactase.

Chapter 4

1A, 2B, 3D, 4D, 5B, 6A, 7C, 8B, 9D, 10D,

11 Refer to Figure 413
The results of the self-fertilisation of the F1 will be:
genotypes: 25% TT, 50% Tt, 25% tt
phenotypes: 75% tall, 25% short

12 w+ = wild type
w = black
A x B gives only wild type colour so at least one parent must be w+w+
A x C gives some black (ww) so both A and C must have a w allele and be w+w
B x C gives only wild type colour so at least one parent must be w+w+
Therefore A is w+w
B is w+w+
C is w+w

13 (a) Exp A: Yellow is dominant over white
Exp B: Short is dominant over long

(b)

phenotypes possible	genotypes
yellow	YY or Yy
white	yy
short	SS or Ss
long	ss

(c) since the F1 contains some long plants with white flowers, their genotype is yyss. The genotype of the parent plant with white flowers and long stems is also yyss. So the yellow flowered short stemmed parent must be heterozygous YySs.

Punnett square		yyss	genotype parent
		ys	gametes
YySs	YS	YySs yellow short	genotype offspring phenotype offspring
	Ys	Yyss yellow long	genotype offspring phenotype offspring
	yS	yySs white short	genotype offspring phenotype offspring
	ys	yyss white long	genotype offspring phenotype offspring
genotype parent	gametes		

There is 25% chance of each of the types of offspring. The results found match this ratio

14 If a mouse has two c alleles, it will not be able to produce pigment, so it will be albino. It will still have the alleles for wild type colour or black colour but they will not be seen because the mouse will be albino. If a mouse is wild-type colour or black colour, it has at least one allele for making pigmnt (C).

phenotypes possible	genotypes
albino	ccAA or ccAa or ccaa
wild type	CCAA or CCAa or CcAA or CcAa
black	CCaa or Ccaa

(a)

Punnett square		ccAA (albino)	genotype parent
		cA	gametes
CCaa (black)	Ca	CcAa wild type	genotype offspring phenotype offspring
genotype parent	gametes		

(b)

Punnett square		CcAa				genotype parent
		CA	Ca	cA	ca	gametes
CcAa	CA	CCAA wild type	CCAa wild type	CcAA wild type	CcAa wild type	genotype offspring phenotype offspring
	Ca	CCAa wild type	CCaa black	CcAa wild type	Ccaa black	genotype offspring phenotype offspring
	cA	CcAA wild type	CcAa wild type	ccAA albino	ccAa albino	genotype offspring phenotype offspring
	ca	CcAa wild type	Ccaa black	ccAa albino	ccaa albino	genotype offspring phenotype offspring
genotype parent	gametes					

The ratio of the phenotypes of the offspring will be
wildtype: 9
black: 3
albino: 4

15 (a) *Refer to Figure 414.*
Baby has phenotype B so can have genotype I^BI^B or I^Bi.
Mother is type A so can be genotype I^AI^A or I^Ai.
Father's father is type A so can be genotype I^AI^A or I^Ai.
Father's mother is type B so can have genotype I^BI^B or I^Bi.
Baby does not have an allele I^A so he must have received allele I from his mother.
Baby is type B so he must be I^Bi, as he has received I from his mother.

(b) In order to be I^Bi, he must have received I^B from his father who must have been I^Bi, having received I from his father (the paternal grandfather of the baby who was type A) and I^B from his mother (the paternal grandmother who was type B).
Paternal grandfather must have been I^Ai.
Paternal grandmother was either I^BI^B or I^Bi.

16

possible phenotypes	genotypes
red polled	$C^R C^R$ PP or $C^R C^R$ Pp
red horned	$C^R C^R$ pp
roan polled	$C^R C^W$ PP or $C^R C^W$ Pp
roan horned	$C^R C^W$ pp
white polled	$C^W C^W$ PP or $C^W C^W$ Pp
white horned	$C^W C^W$ pp

(a) P: red polled *(phenotypes)* x white horned

$C^R C^R P^P$ *(genotypes)* x $C^W C^W$ pp

$C^R P$ *(gametes)* x $C^W p$

F1 CR CW Pp *(genotype)*
roan polled *(phenotype)*

(b) A Punnett square can be used to help work out the F2 generation

Punnett square		CR CW Pp				genotype F1
		CR P	CR p	CW P	CW p	gametes
CR CW Pp	CR P	CR CR PP red polled	CR CR Pp red polled	CR CW PP roan	CR CW Pp roan polled	genotype F2 phenotype F2
	CR p	CR CR Pp red polled	CR CR pp red horned	CR CW Pp roan polled	CR CW pp roan horned	genotype F2 phenotype F2
	CW P	CR CW PP Roan polled	CR CW Pp roan polled	CW CW PP white polled	CW CW Pp white polled	genotype F2 phenotype F2
	CW p	CR CW Pp roan polled	CR CW pp roan horned	CW CW Pp white polled	CW CW pp white horned	genotype F2 phenotype F2
genotype F1	gametes					

F2: red polled (3) + red horned (1) + roan polled (6) + roan horned (2) + white polled (3) + white horned (1)

17

phenotypes possible	genotypes
male normal	XHY
male haemophiliac	XhY
female normal	XHXH
female carrier	XHXh
female haemophiliac	XhXh (usually fatal)

(a) Mother must be carrier XHXh. Father is normal XHY. Since Mohammed is male, he cannot be a carrier so he has no chance of passing on the haemophilia allele to his children. He could have children with haemophilia if his wife is a carrier.

(b) Latifa inherits a normal allele from her father XH. She has 50% chance of inheriting a normal allele from her mother XH but also 50% chance of inheriting the haemophila allele from her mother Xh. So she has a 50% chance of being a carrier. If she is a carrier, she will pass her haemophilia allele on to 50% of her children. That means that each of her sons will have a 50% of being a haemophiliac and each of her daughters will have a 50% chance of being a carrier.. So if Latifa is a carrier, 25% of her children are likely to be haemophiliacs.
The above is based on the assumption that Latifa's husband is not a haemophiliac.

18 *Similarities*:

- in both divisions, chromosomes move to the equator
- meiosis II is similar to mitosis
- both involve spindle formation
- in both chromosomes/homologous pairs move to the poles
- both increase the number of cells

Differences

	mitosis	meiosis
purpose	growth, repair	production of gametes
number of divisions	one	two
number of cells produced	two	four
possible in	haploid/diploid nuclei	diploid (or more) nuclei
nuclei produced	as parent	haploid (reduction division)
chromosome movement	chromosomes line up at the equator	meiosis I: homologous pairs line up at the equator
crossing over	no	possible
chiasmata	no	possible

19 Just match the shapes.

Chapter 5

1B, 2D, 3A, 4C, 5A, 6D, 7A, 8C, 9A, 10A, 11C, 12C, 13C, 14B, 15A, 16D,

17 There are many possibilities here but one example is given below:

1. a. insect has wings . . go to 2
b. insect does not have wings . go to 6

2. a. wings are shorter than body . go to 3
b. wings are as long as body .. go to 4

3. a. body is gray .. .. E
b. body is striped . . F

4. a. antennae are short . .. G
b. antennae are long . . go to 5

5. a. antennae are feathered . H
b. antennae are not feathered . I

6. a. insect has tails . . go to 7
b. insect does not have tails .. go to 8

7. a. insect has two tails . .. A
b. insect has three tails . .. B

8. a. insect has antennae . .. C
b. insect does not have antennae . D

18 (a) Species: a group of organisms that can interbreed and produce fertile offspring.

(b) A habitat describes just the environment in which a species normally lives while an ecosystem describes the community and its environment.

19 (a) Carbondioxide levels increase from 315 ppm in 1960 to 368 ppm in 2000. Each year, carbondioxide levels fluctuate around the mean value. The fluctuation is about 4 ppm above and below the mean value.

(b) Suggest reasons for these changes.

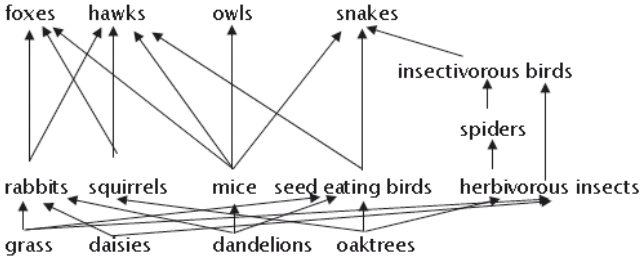
- The overall increase from 1960 to 2000 can be related to the increased use of fossil fuel which produces carbondioxide when burned.
- Deforestation has reduced the number of plants available to reduce carbondioxide levels by photosynthesis.
- The yearly fluctuations are caused by the seasons: in summer, plants photosynthesize more which reduced carbon dioxide levels while they increase in winter when plants have

dropped their leaves and reduced/stopped photosyntesis.

20 (a) Methane and nitrous oxided
(b) Energy from the sun reaches Earth as light rays with a short wavelength. 70% of this will warm up the Earth surface, be changed into Infra Red radiation (with a longer wavelength) and re-radiate into space. Green house gases absorb some of this IR radiation which causes an increase in the temperature of the atmosphere.

21 (a) The precautionary principle comes from the concept of do no harm. Normally, if there is a certain change planned, e.g. building a nuclear power station at a new site, those against the change (e.g. people living in the area) will have to prove that it will be harmful. This is sometimes difficult to do which would make the change go ahead.
If the precautionary principle is applied, then those who want the change (e.g. those building the nuclear power station) will have to prove that it will not do harm. This may also be difficult but failure to do so will stop the change from taking place.
(b) When it is not certain to what degree a species is endangered, the precautionary principle will dictate that they are placed on the level of the most endangered species, giving it the highest level of protection. If it turns out that the species is indeed endangered, then it is placed correctly. Should it be less endangered than originally thought, the higher level of protection has not caused harm to the species. However, if the species were to be placed incorrectly and too low, then it will be given less protection and the species may be seriously reduced in numbers. This would do a considerable amount of damage to the species.

22 It should look something like this:



23 Sexual reproduction increases variation because the genetic material of each individual comes from a sperm and an egg cell.
Mendels first law (law of segregation) says that each trait has two alleles but they are seperated during the formation of gametes so that a gamete has only one allele for each gene.
Mendel's second law (law of independent assortment) says that the combination of alleles from different genes is random and that therefore the gametes of one organism are not all the same.
As a result, the combination of male and female gametes (which is sexual reproduction) will lead to a number of different individuals. This should be knows because it is clear that siblings from one set of parents are not identical to each other.
In addition, it is possible that during Prophase I of Meiosis, an exchange of genetic material between non-sister chromatids occus. This is called crossing over and will lead to more new combinations of genes, causing further variation.

24 The Peppered Moth rests on tree trunks covered in off-white lichens. The moth is the same colour and will spread its wings to blend in with their background. Occasionally a black one appears which is quickly seen and eaten by birds.
As a result of the industrial revolution, trees were covered in soot. Lichens died and the tree trunks became black. The white moth now were eaten more often and the few black ones had the advantage. In only a few years, the black moths were more common than the white ones.

25 (a) *Homo sapiens*. Notice that the name should be in intalics or underlined (when writing by hand). The first letter of the genus name is capitalised, everything else in small print.
(b) Kingdom, phylum, class, order, family, genus, species.

26 *Similarities*: both
- are autotrophs/producers
- have chlorophyll for photosynesis
- have true roots, stems, leaves
- produce seeds

Differences

coniferophyta	angiosperma
have needles	have leaves
no flowers	flowers (although small in wind pollinated plants)
seeds in cones	seeds in ovaries which become fruits

27 (a) all except porifera
(b) all except porifera
(c) platyhelminthes, annelida, mollusca and arthropoda.
(d) porifera, cnidaria

Chapter 6

1C, 2B, 3C, 4A, 5B, 6B, 7C, 8A, 9D, 10A, 11B, 12D, 13B, 14B, 15A, 16A, 17B,

18 (a) Refer to Figure 603
(b)

structure	function
villus	increase surface area which increases absorption
epithelial cells	these cells are permeable to nutrients which need to be absorbed
microvilli	increase surface area which increases absorption
capillary bed near surface of villus	removes absorbed nutrients and maintains concentration gradient proximity to surface reduces distance and speeds up absorption
lacteal	part of the lymphatic system which absorbs and tranports lipids

19 (a) The blood pressure in arteries can be high and a thick wall is needed to prevent the artery from bursting.
(b) Because a lot of the plasma has left the capillary to become tissue fluid and the remaining fluid is more viscous. This is an advantage because there is more time to exchange materials with the tissue
(c) To prevent backflow of blood. Due to the higher pressure and speed of the blood in arteries, there is no risk of back flow there but the low pressure in veins makes it likely to flow in the wrong direction, e.g in the legs when we are standing up.

20
- nutrients
- oxygen
- hormones
- antibodies
- heat
- waste: urea and carbon dioxide

21 (a) antigen enters the organism
(b) lymphocyte that produces the correct antibody will recognise the antigen
(c) lymphocyte will form a clone
(d) all cloned cells produce the same antibody
(e) antibody will make antigen harmless

22 HIV reduces the number of lymphocytes. Lymphocytes make antibodies so HIV reduces antibody production.

23 (a) Refer to Figures 620 and 621.
(b)

structure	function
large surface area	a lot of gas exchange can take place at the same time
thin	short diffusion distance
moist	gases can only cross a membrane when dissolved
good blood supply	maintains concentration gradient

(c) An alvelous privides a large surface area for diffusion of gases into and out of the blood.
(d) To maintain the higher concentration of oxygen and the lower concentration of carbondioxide in the lungs so that oxygen will diffuse from the air in the lungs into the blood and carbondioxide from the blood into the air in the lungs.

24 Both refer to a difference in charge across the membrane of a neuron. A resting potential is fairly stable and usually around -70 mV. An action potential is a change in the potential across the membrane. The electric potential will change from -70 mV to +30 mV and back again. An action potential is what is measured as an impulse is conducted through the neuron.

25 (a) Heat centre in the hypothalamus which senses the temperature and compares it to the desired value. Skin arterioles, muscles that flatten or raise up hairs and sweat glands are all effectors.
(b)
- vasodilation
- sweating
- Increased metabolism
- 'fluffing' of hair or feathers
- thick layer of brown fat or of blubber
- special structure hair

26 Both estrogen and progesterone inhibit secretion of FSH which is necessary for the development of a follicle and hence an egg cell. In the absence of FSH, no follicle will ripen and no egg cell can mature so no fertilisation can take place.

27
- dry skin is difficult to penetrate because it is made of tough cells and there are only few gaps
- normal bacteria growing on the skin will make it more difficult for pathenogenic bacteria to grow
- pH of skin is slightly acidic and many pathogens cannot grow there

- mucus is found where there is not enough protection e.g. air passages
- sticky mucus traps bacteria and stops them from spreading

Chapter 7

1A, 2C, 3A, 4D, 5B, 6D, 7D, 8B, 9D, 10A,

11 Refer to Figure 703 and mention these points
- DNA is made of two strands
- strands are antiparallel
- strands are kept together by hydrogen bonds between the organic bases
- building blocks of DNA are nucleotides
- nucleotides are linked together by covalent bonds
- covalent bonds are created by condensation reactions
- nucleotide consist of a deoxyribose, a phosphate and an organic base
- base is atached to C1, phosphate to C 5
- organic base can be Adenine, Thymine, Cytosine, Guanine
- a base pair between the strands is always A-T or C-G
- ladder is twisted
- approx 10 nucleotides per full turn

12 (a) helicase unwinds the twisted ladder and breaks the hydrogen bonds between the strands which separates the strands
(b) RNA primase will form covalent bonds between the RNA nucleotides to form the RNA primer
(c) DNA polymerase III will form covalent bonds between the DNA nucleotides and the growing strand. It works in a 5' to 3' direction.
(d) DNA polymerase I removes the RNA primers (mostly from Okazaki fragments) and replace RNA nucleotides with DNA nucleotides
(e) DNA ligase will attach the DNA fragments that were the Okazaki fragments to form a complete strand

13 Both need energy and work in the same direction (5' to 3')

transcription	translation
DNA to RNA	RNA to protein
more limited number of mRNA is made each time.	many protein molecules are made almost at the sme time
enzymes needed	enzymes and ribosomes and tRNA needed
in nucleus	in cytoplasm

14 (a) mRNA is an RNA copy of the nonsense strand of the DNA. The sequence of the mRNA codons determines the sequence of the amino acids in the polypeptide.
(b) ribosomes are needed for the tRNA anticodon to bind to the mRNA codon so that the amino acid of the tRNA can be attached to the growing polypeptide chain.
(c) a codon is a sequence of 3 organic bases that codes for a specific amino acid; an anticodon is a sequence of three organic bases(found on tRNA) complementary to the codon.
(d) each tRNA has a specific anticodon. Related to this anticodon, tRNA also carries a particular amino acid so that the same amino acid is always found with the same anticodon. tRNA takes the amino acid to the ribosome and allows it to attach to the growing polypeptide chain.

15
- primary structure: covalent bonds
- secondary structure: hydrogen bonds
- tertiary structure: hydrophobic interactions, disulfide bonds, hydrogen bonds
- quaternary structure: hydrogen bonds, positive/ negative attraction forces, hydrophobic forces, disulfide bridges

16
- enzymes e.g. maltase which breaks down maltose into glucose and fructose
- hormones e.g. insulin
- defense e.g. antibodies/immunoglobins
- strucrure e.g. spindle fibre in cell division
- transport e.g. hemoglobin for oxygen transport

17
- they are used to keep the protein in its place: polar amino acids interact with water on either side of the membrane, non-polar amino acids interact with the non-polar lipid bilayer in the centre of the membrane
- a hollow tube can be created, using polar amino acids at the ends, interacting with the water on either side of the membrane. In the centre, the inside of the cylinder is made of non-polar acids, creating a hydrophilic channel through the membrane.
- polar and non-polar amino acids can help create the shape of the active site of an enzyme and help provide the forces that keep the substrate in the active site and make sure that other substrate do not fit well and do not stay there.

18 (a) at the active site
(b) anywhere on the enzyme as long as it is away from the active site
(c) competitive inhibitor: prontosil
non-competitive inhibitor: cyanide

19
- allostery is non-competitive inhibition
- end product is the inhibitor
- end product will attach to the enzyme
- of an reaction earlier in the metabolic reactions
- at a place which is NOT the active site
- will change the shape of the active site
- enzyme no longer works
- no more product produced
- when product runs out
- then no more product to act as allosteric inhibitor
- so reactiom proceeds
- new product formed.

20
- if reaction is A + B → C
- A and B may need to collide with a high amount of energy
- in order to have reaction take place
- only few particles have this energy
- increasing temperature will increase the number of partciples with sufficient energy
- but this could denature proteins in a living system
- when substrates meet at the active site
- the conditions are such that it is easier for the reaction to take place
- less activation energy is needed
- more particles can react at the same time
- rate of reaction increases.

Chapter 8

1D, 2A, 3D, 4A, 5D, 6D, 7D, 8D,

9 (a) in the cytoplasm
(b) in the matrix of the mitochondria
(c) on the cristae (inner membranes of the mitochondria)

10 Refer to Figure 804

11 (a) The site for the Krebs cycle is the matrix of the mitochondria. It is a watery fluid contaning all the enzymes and compounds needed for the Krebs cycle to proceed.
(b) The site for the electron transport chain is the cristae (folded inner membrane) of the mitochondrion. It has a large surface area so there is a lot of room for many ATP synthetase molecules. It is also impermeable to protons (except where there are ATPase molecules).
(c) Then it would not be possible to build up a higher concentration of protons and chemiosmosis would not work. As a result, no ATP would be produced.

12 Refer to Figure 809.

13 Refer to Figure 810.
The light dependent stage produces ATP and NADPH which are needed to drive the Calvin cycle in the light independent stage. The light independent stage fixes carbon dioxide to produce a triose. This process requires ATP and NADPH, made in the light dependent stage: ATP is needed to phosphorylate GP and to change TP into RuBP. NADPH is needed to reduce glycerate diphosphate into anther triose.

14 (a) they provide the energy and the reducing power to drive the Calvin cycle in the light independent stage.
(b) it is a simple method of producing ATP
(c) non-cyclic photophosphorylation produces NADPH which is needed to drive the light independent stage. The advantage of the light independent stage is that it makes carbohydrates which can be used for long term energy storage but also as building materials for new cells so that the plant can grow and reproduce.
(d) in the Calvin cycle, 3 molecules of carbon dioxide are combined to form a triose molecule; 2 triose molecules will be combined to form glucose.

15 The grana thylakoid provide a large surface for absorbing light the membrane of the grana allows the electron carriers needed for photophosphorylation to be kept in the right order, helping the reaction to proceed. The volume inside the grana is small so that a relatively small number of protons will cause a large difference in concentration across the membrane the stroma is a watery fluid which contains all enzymes and intermediates needed for the Calvin cycle.

16 *Similarities*:
- both use chemiosmosis
- both involve transport of electrons and protons
- both use ATP synthetase to produce ATP from ADP and Pi
- both take place across a membrane which is impermeable to protons
- both buld up a proton gradient across the membrane
- both transport protons into a small space

Differences:

	chloroplasts	mitochondria
site	membrane of granum	membrane of crista
organelle	chloroplast	mitochondrion
source of electrons	water (photolysis)	NADH + H+
ultipmate electron acceptor	NADP	oxygen
protons are pumped into	lumen of the grana	intermembrane space
protons diffuse via ATPase into	stroma	matrix

Chapter 9

1C, 2A, 3C, 4D, 5A, 6D, 7A,

8 (a) Refer to Figure 903

(b) *upper epidermis* reduces water loss
prevent gas exchange
allows light to pass
secretes cuticle
barrier against infection

palisade layer photosynthesis

spongy layer allows rapid diffusion of oxygen and carbon dioxide through air spaces
photosynthesis

lower epidermis stomata open/close to allow gas exchange but reduce water loss
secrete cuticle
barrier against infection

vascular tissue **xylem** transports water and mineral from roots to leaves
phloem transports carbohydrates from source to sink

(c) *upper epidermis* cells close together - no space between for pathogens to enter or water to evaporate
transparent (no chloroplasts) - light can pass easily

palisade layer tighly packed, narrow end to top - maximum exposure to light

spongy layer air spaces allow rapid diffusion of respiratory gases
chloroplasts for photosynthesis

lower epidermis cells close together - no space between for pathogens to enter or water to evaporate
no chloroplasts
stomata allows rapid gas exchange

vascular tissue **xylem** dead cells - no cross walls - facilitates transport of water and minerals
phloem living cells - active transport of carbohydrates

9

	monocotyledenous plants	dicotyledenous plants
veins in leaf	parallel	reticulate (net-like)
distribution of vascular tissue	scattered	in a ring
number of cotyledons in seed	one	two
floral organs	multiples of three	four or five
roots	unbranched	branched
examples	grass, onion, lily and tulip	daisy, oak tree and rose

10
- auxin is group of plant hormones
- auxin is produced by the apical bud of a plant
- auxin is transported down the stem as needed
- auxin stimulates growth
- by promoting cell division and cell stretching
- auxin accumulates on the shaded side of the stem
- which makes the shaded side grow faster
- so the plant grows towards the light
- this increases the amount of light on the leaves
- which increases photosynthesis

11 Water is taken up by osmosis because the concentration of dissolved particles in the root hair cell is greater than that outside. The plant roots take up minerals by active transport this increases the concentration of dissolved particles in the root hair cells. Root hairs increase surface area roots need a large surface area to allow a lot of water uptake at the same time water is taken from roots by xylem. Transpiration pull moves water up the xylem. Cohesion is the force needed for transpiration pull, adhesion enables the water creep up the sides of a capillary tube and supports the flow of water in the plant.

12 Phloem transports sugars and amino acids by pressure flow hypothesis from source (area of production/storage) e.g. leaves or roots to sink (area of use/storage) e.g.fruits/growing points or roots. So carbohydrates/amino acids may go up or down stem at different times. Phloem is made of living cells and transport involves active transport i.e. energy is needed, energy is supplied by companion cells.

13 Please refer to Figure 925.

14 Water is absorbed, gibberelins are made in the cotyledons, amylase is made, starch broken down to maltose which is used to release energy and enable growth.

15 (a) oxygen, water, suitable temperature
(b) *oxygen*: respiration requires energy and oxygen is needed to release energy
water: seeds swell up after taking up water which bursts the testa and the presence of water activates enzymes which hydrolyses large molecules
suitable temperature: germination requires enzymes which need to have a temperature suitable for them to work

16
- there are long day plants, e.g.carnations and clover, and short day plants, e.g. coffee and strawberries
- long day plants flower in summer, short day plants in autumn (and spring)
- long day plants only flower when nights are short
- short day plants only flower when nights are long
- phytochrome regulates the flowering of plants
- two states: Pr and Pfr
- Pr becomes Pfr quickly when exposed to red light
- Pfr becomes Pr slowly in darkness
- long day plants need Pfr to flower
- short day plants only flower when Pfr is absent

CHAPTER 10

1B, 2D, 3C, 4C, 5C, 6A, 7B, 8A

9 Refer to Figure 1001

Interphase: DNA replication.

Prophase I: Chromosomes condense.
Nucleolus becomes invisible.
Spindle formation.
Synapsis: homologous chromosomes side by side.
(the pair is now called a bivalent, the crossover points are called chiasmata).
*Nuclear membrane disappears (sometimes considered as early metaphase).

Metaphase I: Bivalents move to the equator.

Anaphase I: Homologous pairs split up, one chromosome of each pair goes to each pole.

Telophase I: Chromosomes arrive at poles.
*Spindle disappears.

Prophase II: New spindle is formed at right angles to the previous spindle.

Metaphase I: Chromosomes move to the equator.

Anaphase II: Chromosomes separate, chromatids move to opposite poles.

Telophase II: Chromosomes have arrived at poles.
Spindle disappears.
Nuclear membrane reappears.
Nucleolus becomes visible.
Chromosomes become chromatin.

10 (a) Mendel's second law: law of independent assortment.
Any one of a pair of characteristics may combine with either one of another pair.
(b) Mendel's second law does not apply to linked genes. They inherit together except for those cases where crossing over occurs.

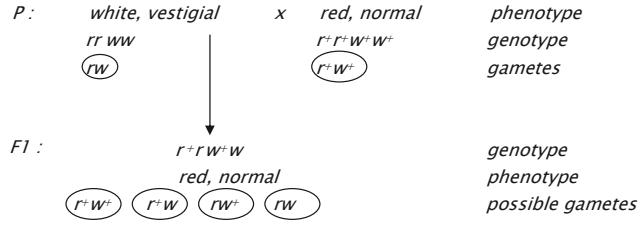
11 (a) wild type colour, wild type wings
(b) All possible phenotypes and genotypes are:
r^+ is red eyes, r is white eyes
w^+ is normal wings, w is vestigial wings

possible phenotypes	corresponding genotypes
red normal	$r^+r^+w^+w^+$, $r^+r\ w^+w^+$, $r^+r^+w^+w$, $r^+r\ w^+w$
red vestigial	r^+r^+ww, $r^+r\ ww$
white normal	$rr\ w^+w^+$, $rr\ w^+w$
white vestigial	rr ww

Possible genotypes of the parents:

parent	phenotype	possible genotypes
1	white eyes, vestigial wings	rr ww
2	red eyes, normal wings	$r^+r^+w^+w^+$, $r^+r\ w^+w^+$, $r^+r^+w^+w$, $r^+r\ w^+w$

(c)



PUNNET SQUARE		Red, normal			
		r^+w^+	r^+w	rw^+	rw
Red, normal	r^+w^+	r^+r^+ w^+w^+ red, normal	r^+r^+ w^+w red, normal	r^+r w^+w^+ red, normal	r^+r w^+w red, normal
	r^+w	r^+r^+ w^+w red, normal	r^+r^+ ww red, vestigial	r^+r w^+w red, normal	r^+r ww red, vestigial
	rw^+	r^+r w^+w^+ red, normal	r^+r w^+w red, normal	rr w^+w^+ white, normal	rr w^+w white, normal
	rw	r^+r w^+w red, normal	r^+r ww red, vestigial	rr w^+w white, normal	rr ww white, vestigial

(d) *genotypes of the F2:*

r^+r^+ w^+w^+: 1	r^+r w^+w^+: 2	rr w^+w^+: 1
r^+r^+ w^+w: 2	r^+r w^+w: 4	rr w^+w: 2
r^+r^+ ww: 1	r^+r ww: 2	rr ww: 1

phenotypes of the F2:

red, normal:	9
red, vestigial:	3
white, normal:	3
white, vestigial:	1

12 Since haemophilia is a sex-linked trait, boys either display the disease or do not possess the allele. Girls may be carriers, i.e. appear healthy but be able to pass on the trait.
Edward VII was Queen Victoria's oldest son. He did not display hemophilia so did not possess the trait so could not pass it on to his children. Several of Victoria's daughters probably were carriers and passed the trait on to their offspring. Males would display the trait, e.g. Alexis, son of Nicolas II of Russia and Alexandra (granddaughter of Queen Victoria). Daughters could be carriers.

13 (a)

possible phenotypes	corresponding genotypes
grey, straight	$g^+g^+s^+s^+$, $g^+g\ s^+s^+$, $g^+g^+s^+s$, $g^+g\ s^+s$
grey, curly	g^+g^+ss, $g^+g\ ss$
black, straight	$gg\ s^+s^+$, $gg\ s^+s$
black, curly	$gg\ ss$

A heterozygous grey, straight winged fly has genotype g+g s+s.
A black, curly winged fly has genotype gg ss.

P: *grey, straight* $g^+g\ s^+s$ g^+s^+, g^+s, gs^+, gs *x* *black, curly* $gg\ ss$ gs *phenotype genotype possible gametes*

F1 $g^+g\ s^+s$ *grey straight* | $g^+g\ ss$ *grey curly* | $gg\ s^+s$ *black straight* | $gg\ ss$ *black curly* | *genotypes phenotypes*

(b) The expected ratios for the phenotypes would be grey straight: grey curly: black straight: black curly = 1 : 1 : 1 : 1

(c) As the ratios found show a much higher occurrence of the parental phenotypes, it suggests that the Law of independent assortment did not apply here, which suggests that the traits are linked.

14 (a) C = coloured, c = albino; G = grey, g = black

possible phenotypes	corresponding genotypes
coloured grey	CCGG, CCGg, CcGG, CcGg
coloured black	CCgg, Ccgg
albino	ccGG, ccGg, ccgg

Parent 1: homozygous recessive albino: ccgg
Parent 2: homozygous grey: CCGG

P: *albino* *ccgg* *cg* *x* *grey* *CCGG* *CG* *phenotype genotype gametes*

F1: *CcGg* *grey* (*CG*) (*Cg*) (*cG*) (*cg*) *genotype phenotype gametes*

All F1 have the phenotype grey and the genotype CcGg.

(b & c) The predicted ratios of the genotypes of the F2 can be found using a Punnett square. The results will be

CCGG:	1	CcGG:	2	ccGG:	1
CCGg:	2	CcGG:	4	ccGg:	2
CCgg:	1	CcGG:	2	ccgg:	1

(d & e) The predicted ratios of the phenotype of the F2 can be found by using a Punnett square. They are grey : black : albino = 9 : 3 : 4
Normally, the phenotypic ratio of this kind of dihybrid cross is 9:3:3:1 but in this case the "albino grey" and "albino black" are both albino and therefore have the same phenotype. Hence the numbers are added, giving the above ratio.

Chapter 11

1D, 2B, 3C, 4A, 5B, 6C, 7C, 8A, 9B, 10D, 11B, 12B, 13A, 14C, !5C, 16D, 17C, 18D, 19B, 20A, 21D,

22 (a) Helper T cells will form a clone and select and activate the correct B cells.

(b) B cells divide to form clones which produce plasma cells and memory cells. Plasma cells produce antibodies against the antigen detected. Memory cells remain present after the infection has passed in order to speed up the production of antibodies in case the antigen is detected again.

23 (a) *Benefits:*

- total elimination of the disease (e.g. smallpox)
- prevention of pandemics and epidemics
- decrease health care costs
- prevent harmful side effects of diseases (e.g. paralysis after polio or problems with eyesight of the child after rubella infection of the mother.

(b) Dangers:

- some vaccines contained the preservative Thimerosal which contains mercury which, at high levels, causes damage to the brain, especially in babies and infants. The preservative was needed to make sure that no other pathogens would grow in the solution with the vaccine. No evidence was found of harmful effects of mercury in vaccinations but as a precaution, it is now used less and less.
- it is possible that an overload of the immune system, e.g. caused by vaccinations against many different diseases in a short time, may make the vaccination less effective and/or cause other problems. It has been speculated that Gulf War syndrome may have been caused by the many vaccinations to protect soldiers from agents of biological warfare.
- a possible link between MMR vaccination and an increased chance of autism; studies carried out since have failed to confirm this link.

24 When a nerve impulse arrives at the muscle, the depolarisation of the motor end plate is passed on to the sarcoplasmic reticulum which causes it to release calcium ions (Ca^{2+}) into the sacroplasm. The calcium ions attach to the troponin which is attached to the tropomyosin. This uncovers the binding sites on the actin for the myosin hooks. The muscle will now contract.

(a) Ca^{2+} is released from the sarcoplasmic reticulum into the sarcoplasm. The calcium ions attach to the troponin which is attached to the tropomyosin.

(b) When troponin binds to calcium ions, it changes its shape. As troponin is attached to tropomyosin, this then makes the tropomyosin move and uncovers the binding sites on actin for the myosin hooks.

(c.) Hooks on myosin will attach to the binding sites on actin. The hooks will then release and repeat the action further down the actin. This is called the ratchet mechanism.

(d) ATP is hydrolysed to ADP. In this process, energy is released which drives the ratchet mechanism.

25

- muscles only contract when they receive an impulse from a nerve
- nerve cells carry depolarisations to muscles
- impulse causes release of calcium in the muscle
- muscle contracts
- muscle is attached to at least 2 bones via tendons
- bones are attached to each other via joint and ligaments
- leverage of bone will make the distance of movement of the bone more than the distance the muscle contracted
- bones move relative to each other (using joints)
- different joints allow different kinds of movement
- antagonistic muscles cause opposite movement

26 *Similarities*:

All blood cells and proteins should remain in the blood.

Since glucose and proteins will not be excreted, the amounts should remain the same. However, it is possible that the concentration has increased if water has been removed.

Differences:

	renal artery	renal vein
urea	more	less
oxygen	more	less
carbon dioxide	less	more
salt	usually more	usually less
hormones	more	less
toxins (e.g. medicin)	more	less

27 (a) oogenesis is the process of forming ova (egg cells).

(b) mitosis occurs in the germination epithelium. One cell mitotically divides into two, one of them

proceeds with oogenesis (the primary oocyte), the other remains as germination cell and can have another mitotic division.

(c) meiosis reduces the number of chromosomes in the gamete. Since a gamete needs to fuse with another gamete to start a new individual, each gamete must have half the number of chromosomes so that the new organism has the same number as either parent.

(d) spermatozoa are very small and the 4 spermatids that result from Meiosis I and II can all become spermatozoa. Ova are very large since they need to contain reserve food for the zygote. If each of the cells produced in Meiosis I and II would be an ovum, then each ovum would only contain one quarter of the reserve food of the original primary oocyte. As it is, two or three polar bodies are produced to reduce the amount of genetic material but almost all the cell material goes to one ovum, giving it the best chance to grow out to a new individual if it is fertilised.

28 (a) HCG is secreted by the trophoblastic cells of the developing embryo

(b) HCG maintains the corpus luteum which produces progesterone

(c) At a later stage, the placenta will start to produce progesterone so the corpus luteum no longer is needed.

(d) Obtain monoclonal antibodies against the HCG (human chorionic gonadotropin). Fix them in place on a testing stick/strip. Add urine to the testing stick/strip. If the HCG is present in the urine (as it will be if the woman is pregnant), it will attach to the antibodies. The test has been so designed that this will give a colour showing a positive test.

Chapter 12

1
- not enough proteins in the blood
- tissue fluid is not returned to the blood
- fluid retention
- retardation of mental and physical growth.

2 (a) PKU is phenylketouria.

(b) PKU is a genetic disorder. PKU patients lack the gene to produce functioning phenylalanine hydroxylase.

(c) Phenylalanine hydroxylase changes phenylalanine into tyrosine. Without this enzyme, phenylalanine accumulates and is changed into phenylpyruvic acid which causes retardation.

(d) PKU causes severe problems unless it is diagnosed early and a special diet is followed. So in many countries all babies are screened within hours after birth.

(e) The diet focusses on avoiding most protein since levels of phenylalanine (an amino acid) must be kept low. With low levels of phenylalanine in the diet, the affected children lead normal lives.

3 (a) antioxidant activity
collagen synthesis
role in immune system
reduce chance of forming arterial plaque

(b) Current FDA recommendation is 70 mg/day.

(c) megavitamin therapy of vitamin C may reduce chance of respiratory infection and/or cancer.

(d) rebound malnutrition is caused by taking larger doses of e.g. vitamin C for an extended time. The organism will excrete the surplus and if levels are then reduced back to normal, it may take time to stop the excretion so that the organism actually suffers from a lack of vitamin C.

4 (a) sex (male/female); level of activity; age (which also relates to activity, size and growth); special circumstances e.g. disease or pregnancy/nursing.

(b) sex: males need more energy than females because males tend to be larger and females tend to have more subcutaneous fat (less heat lost).
level of activity: the more active a person, the more energy is needed.
age: younger is smaller smaller people need less energy but (fast) growing people need more energy whereas older people are often less active so need less energy.
special circumstances:
recovering from illness make require extra energy
pregnancy/breastfeeding will require extra energy

5
- fibre is not digested
- causes slight irritation of the wall of the intestine
- increases peristalsis
- moves food faster through intestine
- softer stools (feces)
- reduced constipation and hemaroids
- may help weight loss as people feel full sooner on high fibre diet
- may reduce cholesterol levels but not proven

6 (a)

	Human milk	Artificial milk
monosaccharide	rich in lactose	no or little lactose
protein	more whey, less casein	less whey, more casein
antibodies	present	absent
fats	rich in omega-3 fatty acids (DHA)	some brands add DHA but usually less than in human milk
enzyme	contains lipase	no lipase
minerals	most iron absorbed	most iron not absorbed

(b) *advantages of breastfeeding*:
- breast milk contains antibodies which help the baby fight infections
- proteins in breast milk are easier digested than those in artificial milk
- calcium and iron in breast milk are better absorbed
- breast feeding helps the uterus contract so that the bleeding after delivery will be shorter
- breast feeding reduces the risk of breast cancer
- breast feeding improves the bond between mother and child
- breast feeding is cheaper - very important in some parts of the world
- mother usually does not ovulate while breast feeding (natural contraception)

disadvantages of breast feeding
- if the mother takes medication for an illness, it may also be found in breast milk
- breast feeding requires more strength from the baby than bottle feeding so weak/ill babies may not be able to get enough milk
- there may be an increased chance of post natal depression but this is not proven

Chapter 13

1
- muscles need energy to contract
- glycogen can be broken down to glucose
- glucose can be used to release energy/ATP
- in aerobic and anaerobic respiration
- aerobic respiration releases most energy/ATP
- and takes place in mitochondria
- if sufficient oxygen is available

2
- myoglobin is protein
- made of one chain of polypeptide
- able to bind oxygen
- stored in muscles
- myoglobin has greater affinity for oxygen than haemoglobin
- makes myoglobin store oxygen
- oxygen released from myoglobin when all available oxygen used up.

3 (a) *Benefits*
- increased amount of oxygen can be taken to muscles
- so more aerobic respiration/less anaerobic respiration
- more energy yielded per molecule of glucose
- more energy available/energy available for longer time
- less lactate produced - lactate can lead to fatigue and muscle cramp
- more chance to win
  personal achievement/honour
  team achievement/honour
  prize money / scholarship / commercial opportunities

Risks
- to be disqualilfied and/or prosecuted
- knowledge that you gained an unfair advantage
- anabolic steroids: liver damage, fertility problems, females become more masculin
- blood doping:
- more viscous blood - heart failure, stroke
- improperly stored - infection
- using donor blood - transmission of e.g. HIV or hepatitis
- EPO: more viscous blood - heart failure, stroke

4

Sprains	overstretching of a ligament in a joint
Torn ligaments	overstretching of a ligament causing rupture
Torn muscle	most severe case of muscle strain; muscle fibres may tear
Dislocation of joints	the bones in the joint are moved, relative to each other, and do not return to their original position
Intervertebral disc damage	one of the discs may may buldge out and put pressure on the nerves in the spinal cord.

Chapter 14

1D, 2A, 3D, 4A, 5D, 6A, 7D, 8D, 9D, 10D,

11
- primary structure: covalent bonds
- secondary structure: hydrogen bonds
- tertiary structure: hydrophobic interactions, disulfide bonds, hydrogen bonds
- quaternary structure: hydrogen bonds, positive/ negative attraction forces, hydrophobic forces, disulfide bridges

12
- enzymes e.g. maltase which breaks down maltose into glucose and fructose
- hormones e.g. insulin
- defense e.g. antibodies/immunoglobins
- strucrure e.g. spindle fibre in cell division
- transport e.g. hemoglobin for oxygen transport

13
- they are used to keep the protein in its place: polar amino acids interact with water on either side of the membrane, non-polar amino acids interact with the non-polar lipid bilayer in the centre of the membrane
- a hollow tube can be created, using polar amino acids at the ends, interacting with the water on either side of the membrane. In the centre, the inside of the cylinder is made of non-polar acids, creating a hydrophilic channel through the membrane.
- polar and non-polar amino acids can help create the shape of the active site of an enzyme and help provide the forces that keep the substrate in the active site and make sure that other substrate do not fit well and do not stay there.

14 (a) at the active site
(b) anywhere on the enzyme as long as it is away from the active site
(c) competitive inhibitor: prontosil
non-competitive inhibitor: cyanide

15
- allostery is non-competitive inhibition
- end product is the inhibitor
- end product will attach to the enzyme
- of an reaction earlier in the metabolic reactions
- at a place which is NOT the active site
- will change the shape of the active site
- enzyme no longer works
- no more product produced
- when product runs out
- then no more product to act as allosteric inhibitor
- so reactiom proceeds
- new product formed.

16
- if reaction is A + B → C
- A and B may need to collide with a high amount of energy
- in order to have reaction take place
- only few particles have this energy
- increasing temperature will increase the number of partciples with sufficient energy
- but this could denature proteins in a living system
- when substrates meet at the active site
- the conditions are such that it is easier for the reaction to take place
- less activation energy is needed
- more particles can react at the same time
- rate of reaction increases.

17 (a) in the cytoplasm
(b) in the matrix of the mitochondria
(c) on the cristae (inner membranes of the mitochondria)

18 Refer to Figure 804

19 (a) The site for the Krebs cycle is the matrix of the mitochondria. It is a watery fluid contaning all the enzymes and compounds needed for the Krebs cycle to proceed.
(b) The site for the electron transport chain is the cristae (folded inner membrane) of the mitochondrion. It has a large surface area so there is a lot of room for many ATP synthetase molecules. It is also impermeable to protons (except where there are ATPase molecules).
(c) Then it would not be possible to build up a higher concentration of protons and chemiosmosis would not work. As a result, no ATP would be produced.

20 Refer to Figure 809.

21 Refer to Figure 810.
The light dependent stage produces ATP and NADPH which are needed to drive the Calvin cycle in the light independent stage. The light independent stage fixes carbon dioxide to produce a triose. This process requires ATP and NADPH, made in the light dependent stage: ATP is needed to phosphorylate GP and to change TP into RuBP. NADPH is needed to reduce glycerate diphosphate into anther triose.

22 (a) they provide the energy and the reducing power to drive the Calvin cycle in the light independent stage.
(b) it is a simple method of producing ATP

(c) non-cyclic photophosphorylation produces NADPH which is needed to drive the light independent stage. The advantage of the light independent stage is that it makes carbohydrates which can be used for long term energy storage but also as building materials for new cells so that the plant can grow and reproduce.

(d) in the Calvin cycle, 3 molecules of carbon dioxide are combined to form a triose molecule; 2 triose molecules will be combined to form glucose.

23 The grana thylakoid provide a large surface for absorbing light the membrane of the grana allows the electron carriers needed for photophosphorylation to be kept in the right order, helping the reaction to proceed. The volume inside the grana is small so that a relatively small number of protons will cause a large difference in concentration across the membrane the stroma is a watery fluid which contains all enzymes and intermediates needed for the Calvin cycle.

24 *Similarities*:

- both use chemiosmosis
- both involve transport of electrons and protons
- both use ATP synthetase to produce ATP from ADP and Pi
- both take place across a membrane which is impermeable to protons
- both buld up a proton gradient across the membrane
- both transport protons into a small space

Differences:

	chloroplasts	mitochondria
site	membrane of granum	membrane of crista
organelle	chloroplast	mitochondrion
source of electrons	water (photolysis)	NADH + H+
ultipmate electron acceptor	NADP	oxygen
protons are pumped into	lumen of the grana	intermembrane space
protons diffuse via ATPase into	stroma	matrix

Chapter 15

D1 ORIGIN OF LIFE ON EARTH

1. A Miller and Urey placed methane, ammonia, water and hydrogen into their apparatus to stimulate the hydrogen-rich reducing atmosphere believed to have been present on the pre-biotic Earth.

2. D An endosymbiont is an organism that has a mutally beneficial symbiotic relationship with a host organism while living in the host. Eukaryotes probably evolved when larger prokaryotes absorbed smaller prokaryotes and formed a symbiotic relationship.

3. B Current living organisms on the Earth's surface are protected from the harmful and damaging effects of ultraviolet radiation by the ozone layer in the upper atmosphere. The ozone molecules absorb solar ultraviolet radiation.

4. A The early atmosphere of the pre-biotic Earth is thought to have been reducing in nature due to the absence of oxygen. It is believed that oxygen only entered the atmosphere following the appearance of photosynthetic prokaryotes.

5. A The first organic molecule able to replicate on the pre-biotic Earth is currently believed by many Molecular Biologists to have been RNA. This hypothesis has been strengthened by the discovery of ribozymes which consist of short lengths of catalytic RNA. The ribosome may also employ catalytic RNA during protein synthesis.

6. C The pre-biotic atmosphere is thought to been reducing in nature and characterised by hydrogen and carbon rich molecules. The presence of oxygen would have made the atmosphere oxidising in nature and prevented the pre-biotic synthesis reactions.

7. C The endosymbiotic theory suggests that the ancestors of some eukaryotic organelles, notably the chloroplast and mitochondria, were originally free-living prokaryotes that entered into a symbiotic relationship with another prokaryote to form an ancestral eukaryote cell.

8. D There is no atmosphere or liquid water on the Moon and the daily range in surface temperatures is too high to support life.

9. D A common feature of all living organisms, including viruses, is that they contain nucleic acids (DNA and /or RNA).

10. A Oxygen was probably not present in the Earth's early atmosphere. The majority of the oxygen present in the current atmosphere was generated by photosynthesis. The Earth's early pre-biotic atmosphere probably originated from volcanic gases - free oxygen gas was not present.

11. B The current estimate of the Earth's age, based upon dating of the oldest rocks, is about 4.5 billion years ago.

12. B Clays may have catalysed the formation of organic polymers, such as proteins and nucleic acids, on the surface of their lattices.

13. D The observation that DNA in the eukaryotic nucleus codes for many of the enzymes in mitochondria is not strong and direct evidence for the role of endosymbiosis in the origin of eukaryotes. (However, it could be argued that over time many mitochondrial genes were transferred to the nucleus).

14. B Proteinoid microspheres are only formed when amino acids are heated at relatively high temperatures for a prolonged period of time.

15. D This is a description of the endosymbiotic theory.

16. A Prokaroytes do not possess lysosomes or Golgi apparatus. Their digestive enzymes are present in the cytoplasm.

17. C The theory that life on Earth was initiated by the arrival of organic molecules and, perhaps even bacteria on asteroids and meteorites, is termed panspermia.

18 Both mitochondria and chloroplasts can arise only from pre-existing mitochondria and chloroplasts by a process of binary fission. (They cannot be formed in a cell that lacks them because nuclear genes encode only some of the proteins of which they are composed).
Both mitochondria and chloroplasts have their own genome and it resembles that of prokaryotes not that of the nuclear genome: both genomes consist of a single circular molecule of DNA and there are no histones associated with the DNA.
Both mitochondria and chloroplasts have their own ribosomes (70S), which closely resemble that of prokaryotes not the 80S ribosomes found in the cytoplasm of eukaryotes.
A number of antibiotics that act by blocking protein synthesis in bacteria also block protein synthesis within mitochondria and chloroplasts. They do not interfere with protein synthesis in the cytoplasm of the eukaryotes.
Conversely, inhibitors of protein synthesis by eukaryotic ribosomes do not have any effect on bacterial protein synthesis nor on protein synthesis within mitochondria and chloroplasts.

19 Miller and Urey used a reflux apparatus to re-circulate water vapour and a mixture of methane, ammonia and hydrogen (believed to reflect the composition of the early atmosphere) through a chamber where they were exposed to a continuous high voltage electrical discharge (spark) that stimulated lightning. After several days Miller and Urey analysed the mixture and detected a number of amino acids. Later experiments involving hydrogen cyanide and ammonia resulted in the formation of the base adenine.

20 Panspermia is a theory or hypothesis, that suggests that the 'seeds' of life are prevalent throughout the Universe and life on Earth began by such 'seeds' landing on Earth and replicating. One line of evidence comes from research that shows there are many more potential habitats for life than Earth-like planets. There is some evidence to suggest that bacteria may be able to survive for very long periods of time even in deep space (and may therefore be the underlying mechanism behind Panspermia). Bacteria and more complex organisms have been found in more extreme environments, such as black smokers or oceanic volcanic vents. Some strains of bacteria have been found living at temperatures above 100 °C, others in strongly alkaline environments, and others in extreme acidic conditions. Semi-dormant bacteria have been found in ice cores over a mile beneath the Antarctic - this lends credibility to the concept of sustaining the components of life on the surface of icy comets. The presence of past liquid water on the planet Mars, suggested by river-like formations, was confirmed by the Mars Exploration Rover missions. Possible water oceans on Europa, one of Saturn's moons, and perhaps other moons in the Solar system.

21 Ribose sugars (found in RNA) are much easier to synthesis under simulated pre-biotic conditions than are deoxyribose sugars (found in DNA). Single stranded RNA, unlike single stranded DNA, can form, via hydrogen bonding a variety of complex three-dimensional configurations. It is suspected that ribosomal RNA plays an active role in the synthesis of proteins in ribosomes. Several RNA sequences have been demonstrated to be catalytic, for example, self-splicing introns – so-called ribozymes.

D2 SPECIES AND SPECIATION

1. C The finches, although originating from the same ancestral species, evolved separately due to the different habitats colonised. A process of adaptive radiation occurred resulting in the formation of

the thirteen new species each adapted to a unique habitat on the island.

2. D The relatively sudden appearance of a number of new species, without intermediates, is termed punctuated equilibrium.

3. A Natural selection is slowest when migration is absent (no new variation is introduced into the population); when the selection pressure is low the rate of evolution will be low and when variation due to gene mutation is low, consequently there will be little genetic variation for natural selection to act on.

4. B All the alleles present in the gametes of a sexually reproducing population are known as the population's gene pool.

5. B Birds A and B successfully interbreed and produce viable offspring. This is the Biological definition of a species (that reproduces sexually)

6. C The term 'Gradualism' in Darwin's theory of evolution refers to the emergence of complex Biological adaptations, for example, the eye, evolved in many small incremental steps.

7. D Members of the same species do vary in phenotype, frequently, two or more varieties or morphs can be identified.

8. B Reproductive barriers prevent different species from successfully interbreeding. The various reproductive barriers which isolate species can be classified as either prezygotic or postzygotic. Prezygotic barriers are mechanisms which prevent the fusion of the ovum and the sperm so that no zygote can form. Postzygotic barriers are mechanisms that prevent a zygote from developing into a fertile adult offspring.

9. A The periodic events in which extinction rates increase dramatically are termed mass extinction events. They may be caused by volcanic eruptions, meteor impacts and/or long term changes in the global climate.

10. A Adaptive radiation is the production of ecologically diverse species from a common ancestral stock or population, for example, Darwin's finches.

11. B The term microevolution refers to an increase or decrease of allele frequencies within a gene pool.

12. C One form of reproductive isolation is spatial isolation. If members of two populations never encounter each other, they will never mate and no gene flow will occur.

13. A Punctuated equilibrium does not invoke large evolutionary steps via macromutations with large effects on the phenotype.

14. D Behavioural isolation involves genetic modifications to behaviour that lead to lack of mating between two groups of a species. Its continued presence may eventually result in speciation.

15. A A pre-zygotic isolating mechanism prevents fertilisation (the fusion of the sperm and ovum nuclei).

16. D Transient polymorphism is being exhibited: there is clearly no balancing selection occurring since there is random mating and both morphs are exhibiting equal reproductive success.

17. D The maintenance of the frequency of both dominant and recessive genes over a number of generations by selecting for the heterozygotes. Balanced polymorphism explains the discrepancy in number of individuals with sickle-cell disease compared to sickle-cell trait in Africa compared to North American blacks.

18. C The increase in the frequency of the dark melanic form of Biston betularia is thought to be the result of natural selection. The dark forms were better camouflaged on the soot covered trunks and thus prone to less predation by birds. The mutation rate would have been approximately constant during this period of time.

19 (a) 2.6% = 2.6/100 = 0.026 (b) $p^2 + 2pq + q^2=1$
Let q represent the frequency of the HbS allele
$q^2=0.026$; $q=\sqrt{0.026}=0.161$

(b) Let p represent the frequency of the HbA allele p + q = 1; p = 1 – 0.161 = 0.839 Hence, frequency of heterozygotes = 2pq = 2 x 0.839 x 0.161 = 0.270
Number of heterozygotes in population
= 600 x0.270 = 162.

(c) Balanced polymorphism is being exhibited.

(d) The force responsible for maintaining this polymorphism is termed heterozygote advantage – the heterozygote is fitter than either homozygote, since it is immune to malaria.

20 (a) Let p represent the frequency of M; p = 0.5 and let q represent the frequency of m; q = 0.5.
At equilibrium the genotype frequencies will be 0.25 MM, 0.5 Mm and 0.25 mm, according to the Hardy-Weinberg equation. Therefore the phenotypic ratio is 0.75 melanic: 0.25 pale.
(b) 500 mm moths will be eaten leaving 500 MM and 1000 mm.
Number of alleles remaining = (2 x 1500) = 3000
Number of M alleles = (2 x 500) + 1000 = 2000
Number of m alleles = 1000
Frequency of M =2000/3000 = 0.667
Frequency of m = 1000/3000 = 0.333
(c) Out of 2000 moths, 500 mm will survive. There are no melanic forms, so the frequency of m = 1.0.
(d) m and M.
(e) Transient polymorphism is being exhibited.

D3 HUMAN EVOLUTION

1. B A. erectus is not a species of Australopithecus. Homo erectus is in a different genus and species.

2. C Anatomical and biochemical evidence, especially maternal mitochondrial DNA sequence analysis, strongly suggest that modern man evolved in Africa. The so-called 'Out of Africa' hypothesis.

3. A The species of Homo in order of evolutionary appearance are: H. habils, H. erectus, H. neanderthalensis and H. sapiens.

4. A In modern humans the head is not kept in position by powerful neck muscles.

5. A Cultural evolution is learned behaviour which is passed from generation to generation via non-genetic processes, for example, transmission of knowledge via books and the passing on of religious beliefs and cultural practices or language.

6. B The first Australopithecine fossils date back to approximately 5 million years ago. They have only been found in Africa.

7. C Binocular vision is a characteristic of the order primates.

8. D The genus Homo lived with the genus Australopithecus in East Africa for about 1 million years.

9. C Homo sapiens made the most sophisticated tools.

10. D All of the hominid skeletons show evidence of bipedalism to some degree.

11. B Tool use is probably restricted to the genus Homo – Homo habilis was the first member of this genus.

12. D Humans and apes are presently classified in the same category at all of the following levels except genus. Humans belong in their own genus (Homo). Apes are divided among four genera. Humans and apes belong in the same Order: Primates, Class: Mammalia, Phylum: Chordata, Kingdom: Animalia.

13. D Of the living genera of apes, the one most closely related to humans are the chimpanzees (that is, the common chimpanzee and the pygmy chimpanzee or bonobo).

14. C Opposable thumbs is a feature that sets primates apart from all other mammals. The ability to produce milk is a characteristic of all mammals that distinguishes them from the other vertebrate Classes; placental embryonic development is a characteristic of the placental mammals that distinguishes them from the marsupials and monotremes.

15. B Two important characteristics of the first hominids were bipedal locomotion and relatively small brains.

16. C The oldest hominid fossils have all been discovered in Africa.

17. B Early hominids dating to between 6 and 3 million years ago are considered primitive because they possessed many ancestral characteristics common to all hominids.

18. B The fossil specimen nicknamed "Lucy" is an example of Australopithecus afarensis.

19. D The fossil footprints at Laetoli show clear bipedal characteristics which include: non-divergent big toe, heel strike and a well developed arch on the foot.

20. A The fossil record strongly suggests that bipedalism evolved 3.5 million years before tool use.

21. C Neoteny refers to a delay in the maturation process, especially that of the cerebral cortex. It is therefore possible that intelligence and learning are enhanced before the organism reaches sexual maturity.

22. D Fossils of Homo erectus have only been found in tropical Africa and Asia, for example, Indonesia.

23. B Cultural evolution is a rapid and powerful force, for example, the transmission of knowledge and skills via learning.

24. C When fossils are unearthed, it is generally found that the bones or shells of the dead organism have been replaced by hard minerals, for example, calcium carbonate.

25. B Water with dissolved oxygen is a poor preservative medium for the remains of animals and plants. These conditions would encourage the growth of bacteria which would digest the remains.

26. C The half life of carbon-14 is relatively short it can only be used to date organic remains that are less than 70,000 years old

27 (a) (i) The genus is Homo; the species is floresiensis.
(ii) To demonstrate that LB1 is not an aberrant individual, but was a typical member of the population.
(b) (i) Dwarfing may be common on islands due to the relatively limited amount of resources, for example, food supply and breeding space and lack of predators. Smaller animals may also be able to achieve thermoregulation on smaller amounts of food.
(ii) A general increase.
(c) It suggests that how the brain is 'wired up', namely, its complexity (the number of neuronal synapses), is perhaps more important than its absolute size or brain to body size ratio.
(d) The use of tools.

28 (a) There are fewer complementary base pairs and hence fewer hydrogen bonds to hold the two strands together.
(b) The DNA of distantly genetically related species has less complementary base pairs and hence there will a greater number of mismatched base pairs. Fewer hydrogen bonds are formed and hence less heat is required to separate or 'melt' the strands. Closely related species will have more complementary based pairs and hence a greater number of matched base pairs. A larger number of hydrogen bonds are formed and hence more heat is required to separate or 'melt' the strands.
(c) 30/7.3= 4.1 million years
(d) 4.1 million years x 1.9 = 7.8 million years
(e) A = gibbons; B = orang-utan

D4 THE HARDY-WEINBERG PRINCIPLE

1. A For a Hardy-Weinberg equilibrium to be maintained and for evolution not occur, there has to be a large population, isolation from other populations (that is, no immigration or migration), no mutations, random mating and no selection pressure.

2. A $p^2 + 2pq + q^2 = 1$ represents the Hardy-Weinberg equation.

3. D In the Hardy-Weinberg equation, p represents the frequency of a dominant allele.

4. B In the Hardy-Weinberg equation, q represents the frequency of a recessive allele.

5. C The Hardy-Weinberg principle assumes that the population is not experiencing mutation.

6. B $p^2 + 2pq + q^2 = 1$; p = 0.7; q = 0.3; 2pq = (2 x 0.7 x 0.3) = 0.42

7. D Significant deviations from the frequencies predicted by the Hardy-Weinberg principle may indicate that natural selection is occurring and hence altering allele and genotype frequencies over time.

8. D $p^2 + 2pq + q^2 = 1$; q^2=0.09; q = 0.09 =0.3

9. B $p^2 + 2pq + q^2 = 1$; q = 0.3, hence p = 0.7;
2pq = (2 x 07 x 0.3) = 0.42

10. C The Hardy-Weinberg principle can be applied to three or more alleles. For example, the expression when applied to three alleles takes the form of $(p + q + r)^2$, which when expanded gives $p^2 + q^2 + r^2 + 2pq + 2rq + 2rp = 1$.

11. A Random mating will maintain the proportion of dominant to recessive characteristics in a population from generation to generation. This is because the population is in Hardy-Weinberg equilibrium and allele frequencies remain constant over time.

12 Frequency of genotype BB = p^2 = 0.82 = 0.64
Frequency of genotype Bb = 2pq = 2 x 0.8 x 0.2 = 0.32
Frequency of genotype bb = q^2 = 0.22 = 0.04

13 p^2 = frequency of AA 2pq = frequency of Aa
q^2 = frequency of aa, whose frequency is 1 in 20000 q^2 = 1/20000 = 0.00005
Therefore, q = √0.00005 = 0.007 p = 1 – q = 0.933
Hence, the frequency of heterozygotes
= 2 x 0.993 x 0.007 = 0.014

14 (a) Let q^2 represent the frequency of the homozygous recessive genotype.
q^2 = = 0.23
In males q = 0.48.
q^2 = = 0.16.
In females q = 0.40.
(b) The samples of males and females are small and the differences in calculated allele frequencies is due to sampling error.

15 (a) q^2=1/1000 = 0.0001, therefore, q = √0.0001 = 0.01
p + q = 1; p = 1 – 0.99
Let 2pq represent the frequency of the heterozygotes.
2pq = 2 x 0.01 x 0.99 = 0.0198
2000 x 0.0198 = 39.6
Hence about 40 people in 2000 would be expected to be heterozygous.
(b) If the couple have already had one phenylketonuric child, they must both be heterozygous. The probability of two heterozygotes having a heterozygous child is or 50%.

16 (a) The 53% resistant rats have the genotypes RR or Rr. The 47% non-resistant rats have the genotype rr.
q^2 = 0.53, therefore q = 0.73; p + q = 1,
therefore p = 1 – q; p = 0.27
Therefore frequency of R allele = 0.27.
(b) p = 0.27 and q = 0.73; p2 = 0.073 (RR); 2pq = 0.39 (Rr); q^2= 0.53
Out of 100 rats, 7 are RR, 40 are Rr and 53 are rr. Non-resistant rats have the genotype rr. If all these rats were killed, there would be 7 RR and 40 Rr rats remaining.
(c) 7 + 40 = 47 animals remaining. 2 x 47 = 94 alleles.
Number of r alleles = 47; frequency of r allele = = 0.5.
Substituting q = 0.5 into the Hardy-Weinberg equation, the frequency of non-resistant rats (rr) = q^2 = 0.25.

D5 PHYLOGENY AND SYSTEMATICS

1. C The universality of the genetic code is strong evidence for a single or unitary origin of life on Earth. It is very conserved and arose early in evolution.

2. C Homology refers to the appearance of a trait that was present in a common ancestor of two or more related groups of organisms.

3. D This phenomenon is known as an evolutionary or molecular clock. It is a consequence of the neutral theory of evolution which holds that in any given DNA sequence, mutations accumulate at an approximately constant rate as long as the DNA sequence retains its original function.

4. D Homologous features imply structural and developmental similarities, where the structures concerned may not perform the same function. The human hand and whale fin both share the same basic pentadactyl limb structure.

5. A This suggests that reptiles, birds, and mammals have a common evolutionary ancestor.

6. B The toad, the amphibian, is the most distantly related, in evolutionary terms, of the organisms. The common ancestor of all toads and all the organisms evolved before the common ancestor of the other organisms.

7. B The term phylogeny describes the branching sequence of the evolution by natural selection of organisms.

Chapter 16

1 (a) retina
(b) rods and cones
(c) rods
Several rods are linked to one bipolar neuron. This means that their impulses are 'added up' and this explains their higher light sensitivity. However it also reduces accuracy.
(d) Rods and cones contain photopigments that are broken down when exposed to light. This causes the cells to send an action potential to the brain.

2 (a) behaviour which normally occurs in all members of a species, including in young and inexperienced animals.

(b) innate behaviour is controlled by genes
(c) taxes and kineses
Euglena going towards the light is a phototaxis.
Woodlice moving faster and turning more often is a kinesis.

3
- learning may benefit individual and/or group
- animals can learn how to catch food efficiently or avoid food
- e.g. bear catching salmon and bird avoiding to eat wasps
- which makes it more efficient
- warning calls increase safety of all individuals in the group
- e.g. monkeys
- other cooperative behaviour
- e.g. hunting of dolphins

4
- **psychoactive** drugs influence the brain by affecting it at the level of the neurotransmitters.
- They can increase or decrease postsynaptic transmission.
- psychoactive drugs can cause dependence
- *excitatory* drugs work by releasing the neurotransmittor, mimicing its effect or reducing or delaying the re-uptake of the neurotransmittor, prolonging its effect
  nicotine stimulates receptors that respond to acetyl choline causes increase in adrenaline making people feel more alert
  cocaine blocks the re-uptake of dopamine causing people to feel happy
  amphetamines release dopamine causing improved concentration and performance
- *inhibitory* drugs block neurotransmittor receptors
  benzodiazepines increases the inhibitory effect of GABA slow down the brain and calm people down
  alcohol increases the inhibitory effect of GABA and reduces inhibitions
  tetrahydrocannabinol THC blocks cannaboid receptors and cause relaxation and pain relief

5 (a) The sympathetic nervous system is part of the autonomous nervous system and not under voluntary control. The sympathetic nervous system is involved in action e.g. fright, fight, flight response
(b) It increases heart rate, contracts the radial muscles of the iris and reduce the blood flow to the gut.
(c) Increasing heart rate will pump more blood round the body, also to the muscles. Blood carries food and oxygen, needed to release energy by cellular respiration. Contracting radial muscles in iris will increase size of pupil which will allow more light into the eye and better vision. Blood will be redirected from the gut to e.g. muscles, increasing speed or strength.

6 (a) Altruism is behaviour which benefits another individual but at cost to the performer
(b) (i) A worker bee being killed while defending the hive
(ii) A male blue throated side blotched lizards form partnerships; occasionally one of them spends so much time defending the territory that he does not mate - the other one can mate because the territory is defended
(iii) Vampire bats regurgitating blood for another bat that did not feed for some days
(c) Genetically related individuals benefit if another individual carrying some of their genes increases its chances of survival.
Reciprocal altruism in bats: individuals benefit from blood regurgitated by others only if they themselves also feed others when needed

Chapter 17

F1 DIVERSITY OF MICROBES

1.D, 2C, 3B, 4D, 5A, 6A, 7D, 8B, 9D, 10D, 11D, 12A, 13C, 14B, 15C, 16C, 17C, 18B, 19B, 20A, 21D, 22A, 23D, 24B, 25D, 26B,

27 (a) Refer to Figures 215 and 1707 in text book
(b) Gram negative bacteria have a much thinner cell wall than Gram positive bacteria. Hence, the cell wall does not retain the stain (crystal iodine complex).
(c) Escherichia and Salmonella.
(d) Both gram negative and gram positive bacteria both exhibit quorum sensing. Briefly outline what happens during this process.
(e) The membrane lipids are composed of straight carbon chains attached to glycerol by an ester linkage (-CO-O-); histones and introns are absent.

F2 MICROBES AND THE ENVIRONMENT

1A, 2C, 3C, 4A, 5C, 6C, 7B

8 Refer to Figure 1726 in the text book

F3 MICROBES AND BIOTECHNOLOGY

1A, 2B, 3D, 4A, 5B, 6D, 7D, 8A, 9A, 10B

F4 MICROBES AND FOOD RODUCTION

1B, 2D, 3D, 4B, 5A

F5 METABOLISM OF MICROBES

1B, 2A, 3C, 4D, 5A

F6 MICROBES AND DISEASE

1A, 2C, 3C, 4A, 5B, 6B, 7C, 8C, 9C, 10C, 11C, 12D, 13A, 14A, 15C, 16A, 17C.

Chapter 18

1 *Similarities*
Both
- are long term relationships
- between organisms of different species
- where at least one of them benefits

Differences:

parasitism	mutualism
one organims benefits, the other is harmed	both organisms benefit
e.g. athlete's foot: fungus growing on damp skin; fungus obtains nutrients from host which loses nutrients	e.g. algae and fungus in lichen algae photosynthesis, fungus takes up water and minerals
e.g. fleas on a dog fleas drink blood from dog which loses blood	sea anemone and clown fish clown fish chases away fish that eat anemones; tentacles of anemone protect clownfish

2 (a) gross production is the amount of organic matter produced by photosynthesis in plants.
(b) net production is gross production minus respiration.
(c) diversity increases as succession proceeds until a maximum, then it reduces some until a climax community is reached. Production increases until a maximum is reached and stabilizes.

3 (a)

	SITE 1		
	n	n-1	n(n-1)
water beetle	19	18	342
water snail	66	65	4290
mosquito fish	19	18	342
leech	11	10	110
diptera larvae	11	10	110
bivalve	786	785	617010
Ostracada	5	4	20
tadpoles	8	7	56
true worms	74	73	5402
sum	999		627682

	SITE 2		
	n	n-1	n(n-1)
Ostracada	16	15	240
tadpoles	32	31	992
true worms	39	38	1482
water hoglouse	157	156	24492
swimming mayfly nymph	102	101	10302
dusky mayfly nymph	16	15	240
non biting midge larva	614	613	376382
'Hawker' dragon fly	16	15	240
sum	992		414370

	site 1	site 2
total number of individuals at each site N	999	992
N-1	998	991
N(N-1)	997002	983072
sum of n(n-1) for all species at one site	627682	414370
simpson's index	1.588	2.372

(b) Simpson's index for site 2 is bigger than for site 1. This means that the diversity at site 2 is greater than at site 1 despite the fact that site 2 has fewer species. The smaller divesity index at site 1 is caused by the fact that only one species is present in large numbers while in site 2 more species have a larger number of individuals.
(c) Site 1 could be more polluted than site 2. Only some species are capable of competing successfully in a polluted environment so the diversity of a polluted area is generally less than that of an unpolluted area. If both sites are from

the same stream, it is likely that site 2 was higher upstream than site 1.
Another possiblity is that succession has proceeded further at site 2 than at site 1, unless site 1 was the climax community.

4 (a) *in situ:* nature reserves e.g. Great Barrier Reef Marine Park in Australia and Yellowstone National Park in the USA.
ex situ: zoos, e.g London Zoo
botanic gardens e.g. New Botanic Garden of the University of Helsinki at Kumpula Manor
seed banks e.g. Millenium Seed Bank Project in Kew (UK)

(b) *benefit of in-situ*
- some species are very hard to breed in captivity
- the population remains adapted to its original habitat, e.g. continue it natural diet
- individuals maintain their natural behaviour
- species interacts with others and fulfills its role in the ecosystem
- the habitat remains available for the endangered species (and others)
- it requires a larger gene pool but then conserves this variation between individuals
- species continues to evolve
- individuals can have more space, e.g. for a territory
- individuals may not need to be transported

uses of ex situ
- protect individuals of a nearly extinct species
- captive breeding programmes can increase number of individuals and maintain some biodiversity
- increasing awareness about exotic or endanged species

5

	r-strategy	K-strategy
body size	small	large
life span	short	long
maturity	early	late
offspring	many	few
care for offspring	little	extensive
population size	fluctuates	stable
environment	unstable	stable
description	opportunistic	stable
example	pathogens and pests e.g. mice	whales and elephants

6 Population size N = n1 x n2 / n3 = 809.25
So the estimate of the total population size would be just over 800 woodlice. Be aware that if the numbers were the same but 9 of the woodlice had been marked, the estimated population size would have been just over 700.

Chapter 19

1 (a) Anti-Diuretic Hormone (ADH)
(b) ADH is produced by cell bodies of neurosecretory cells in the hypothalamus
(c) ADH is stored in the posterior lobe of the pituitary gland and released from the nerve endings of neurosecretory cells there
(d) cells of the wall of the collecting duct
(e) The mechanism is an example of negative feedback: Osmoreceptors in the hypothalamus detect an increase in the concentration of dissolved particles in the blood plasma and cause the release of ADH. ADH travels to the kidneys via the blood, makes the walls of the collecting duct more permeable so more was is reabsorbed and less urine is produced which decreases the concentration of dissolved particles in the blood so stops the release of ADH.

2 (a) Pepsin and trypsin are proteases, if produced in active form would digest the cell that produces them so they are made as pepsinogen and trypsinogen
(b) Pepsinogen is activated by HCl in the stomach. Trypsinogen is activated by enterokinase in the small intestine.
HCl and enterokinase are made by different cells than those who make pepsinogen and trypsinogen.

3 (a) microvilli, mitochondria, pinocytotic vesicles, mitochondria.
(b) *microvilli* increase the surface area, allowing more food to be absorbed at the same time
mitochondria provide energy since some of the processes of absorption are active transport which requires energy
pinocytotic vesicles as a result of endocytosis
tight junctions to prevent particles from entering in between cells

4 (a) glucose, amino acids, hormones, vitamins, cholesterol,

(b) *glucose* is taken up, converted to glycogen and stored
amino acids are used to make (blood) proteins, surplus amino acids are broken down for energy and urea produced as a waste product
vitamins A and D are stored in the liver
cholesterol levels are controlled

5
- genetic factors - if one or more family members have CHD, the risk is increased
- age - CHD is more common with increasing age
- gender - CHD is more common among males
- smoking - smoking increases the chance of CHD
- obesity - obesity increases the chance of CHD
- diet - a diet high in cholesterol and saturated fats increases the chances of CHD; there is evidence that trans fatty acids are particulary unhealthy
- lack of exercise - exercise seems to decrease levels of LDL cholesterol and reduces chances of CHD.

6 (a) As the partial pressure of oxygen increases, the percentage saturation of hemoglobin with oxygen increases as shown by the sigmoid curve. First oxygen is more difficult to attach but it facilitates binding of subsequent oxygen molecules. In lungs, pO_2 is high so hemoglobin is (almost) saturated with oxygen. In tissue, pO_2 is low so hemoglobin releases oxygen (to respiring cells).

(b) Bohr shift = Bohr effect takes place when CO_2 levels are high
e.g. in actively respiring tissues like muscle
High CO_2 levels causes drop in pH, drop in pH makes oxygen dissociation curve go to the right. So at a specific pO_2, hemoglobin will have less oxygen with the Bohr effect, that means more oxygen is released to the tissue which is available for cellular respiration