

The sample answers have been written by the author. IB may award marks differently.

Answers to end of Chapter 1 test

1 C

2 A

3 C

4 C

5 A

6 C

7 A

8 B

9 A

- 10 • Larger molecules are formed by condensation reactions.
- Which release water molecules.
 - Two valid examples/word equations (e.g. amino acid + amino acid \Rightarrow dipeptide + water).
- 11 A source of energy.
- 12 • Water is adhesive **and** cohesive.
- Water is polar.
 - Hydrogen bonds form between water molecules and other water molecules.
 - Hydrogen bonds form between water molecules and xylem walls.
- 13 • Cellulose is a structural carbohydrate that gives cell walls their structure/strength.
- Cellulose is composed of beta glucose.
 - Beta glucose molecules are connected by 1–4 glycosidic bonds.
 - Beta glucose molecules are arranged at 180° from each other.
 - (Resulting in) flat chains/microfibrils of glucose molecules.
 - The flat chains/microfibrils can be stacked on top of each other, providing strength/structure.
 - Hydrogen bonds form between the chains/microfibrils, increasing the strength of the structure.

- 14** • Saturated fatty acids do not contain any carbon to carbon double bonds, whereas unsaturated fatty acids do.
- 15** • Amine group drawn correctly.
- Carboxylic group drawn correctly.
 - Central carbon, hydrogen and R-group drawn correctly.
- 16** • Each strand contains three nucleotides.
- A nucleotide is correctly drawn and labelled (phosphate, deoxyribose, base).
 - Two strands are drawn in antiparallel orientation.
 - Correct base pairing is shown (A–T, G–C).
 - Hydrogen bonds are labelled between base pairs (the number of hydrogen bonds does not need to be correct).
 - Phosphodiester bonds are correctly labelled and positioned between the phosphate of one nucleotide and the carbon 3 of another.
 - The sugar–phosphate backbone is labelled correctly.
- 17** B
- 18** • Chargaff discovered that the ratio of adenine to thymine and cytosine to guanine was a 1:1 ratio.
- This suggested complementary base pairing in the structure of DNA.
- 19** Condensation.
- 20** • Long-term energy storage.
- Cell membrane composition.
 - Insulation for vital organs.
- 21** • Quaternary structure.
- Four polypeptide chains.
 - Conjugated protein/contains a prosthetic group.
 - Iron is part of the prosthetic group.

Answers to end of Chapter 2 test

1 B

2 C

3 C

4 A

5 Temperature [3 marks maximum]

- Increasing temperature **increases** the kinetic energy (of enzymes/substrates).
- Causing **more** collisions between enzymes and substrates/**more** enzyme–substrate complexes form.
- At high temperatures/after the optimum temperature, enzymes denature/the active site changes shape.
- The substrate can no longer bind to the active site. (*Accept once throughout entire answer.*)

pH [3 marks maximum]

- At extremes of pH/very low or high pHs, enzymes denature/the active site changes shape.
- The H^+ ions/ OH^- in acidic/basic/alkaline solutions interact with amino acids.
- The substrate can no longer bind to the active site. (*Accept once throughout entire answer.*)

Substrate concentration [3 marks maximum]

- Increasing substrate concentration **increases** the likelihood of successful collisions between enzymes and substrates/**increases** the number of enzyme–substrate complexes formed.
- At very high substrate concentrations, there are more substrates available than free active sites.
- The rate of reaction reaches a plateau.

- 6
- Fermentation involves anaerobic respiration.
 - Anaerobic respiration in yeast produces ethanol and carbon dioxide.
 - The carbon dioxide makes bread rise.
 - Ethanol can be used to produce alcoholic drinks.
 - Anaerobic respiration in some bacteria produces lactic acid.
 - Lactic acid causes milk **proteins** to denature/coagulate.
 - Lactic acid has a sour taste.
 - Anaerobically respiring bacteria can be used to produce yoghurt.

- 7
- Algae photosynthesise **and** respire.
 - Photosynthesis absorbs/uses carbon dioxide.
 - Respiration releases carbon dioxide.
 - At night, algae respire but do not photosynthesise.
 - At night, the net production of carbon dioxide increases.
 - In the middle of the day, the rate of photosynthesis will exceed the rate of respiration.
 - In the middle of the day, there will be a net absorption of carbon dioxide by the algae.
 - In the morning/evening/at low/middle light intensities, the rate of photosynthesis will equal the rate of respiration.
 - In the morning/evening/at low/middle light intensities, the net production of carbon dioxide will be zero.

- 8
- Isoleucine is a non-competitive inhibitor of **threonine deaminase**.
 - Isoleucine carries out end-product inhibition.
 - Threonine deaminase catalyses the conversion of threonine to isoleucine.
 - At high levels of isoleucine, many isoleucine molecules/inhibitors temporarily bind to the allosteric site (of threonine deaminase).
 - Preventing/slowing the rate of reaction/product of isoleucine.
 - This is an example of negative feedback.

9 A

10 Similarities [2 marks maximum]

- Both produce ATP.
- Both involve the movement of protons down a concentration gradient through ATP synthase.
- Both depend on the accumulation of protons in a small space between two membrane.

Differences [2 marks maximum]

- Occurs across the thylakoid membranes in photosynthesis whereas it occurs in the cristae in respiration.
- Protons move into to stroma in photosynthesis whereas they move into the matrix in respiration.

- 11
- Water molecules are formed in respiration, whereas they are broken up/split in photosynthesis.
 - Water is formed from electrons leaving the electron transport chain in respiration, whereas it provides electrons for the electron transport chain in photosynthesis.

Answers to end of Chapter 3 test

1 C

2 B

3 A

4 B

5 A

6 C

7 A

8 B

9 C

10 • Splicing involves removing introns from mRNA.

- Alternative splicing results in different exons in the mature/processed mRNA.
- Allows production of several types of proteins from one gene.

11 A

12 • Promoter regions allow transcription to occur.

- Telomeres protect the ends of chromosomes from damage.
- Coding for tRNA/rRNA.

13 • Translation produces a polypeptide chain.

- Functional proteins have specific 3D shape which allows them to function.
- Some proteins consist of several polypeptide chains.
- Chaperone proteins help to fold polypeptide chains correctly so they function as proteins.
- Some proteins require the addition of a prosthetic group before they can function.

14 • Epigenetic factors are environmental factors that influence gene expression.

- Specific example of an epigenetic factor and its effects on gene expression given, e.g. different diets affecting unborn offspring in agouti mice result in different coat colour and susceptibility to disorders such as diabetes in offspring.
- Epigenetic factors can prevent transcription (and therefore gene expression).
- Methylation affects gene expression/transcription.
- Detail of methylation included – methylation of histone tails resulting in supercoiling of DNA/methylation of cytosine/bases on DNA strand.
- Methylation/epigenetic factors can affect the binding of enzymes/transcription factors to DNA.

- 15 • A base substitution mutation is usually less harmful because it will only affect the codon for one amino acid, whereas a deletion will change all the subsequent codons and the amino acids which they code for.
- Also, the genetic code is degenerate so not all substitutions result in a different amino acid being incorporated into a polypeptide.
- 16 • mRNA is edited after transcription and before translation.
- Introns are removed by RNA splicing and are not present in the final mRNA. Exons remain and are bonded together to create a shorter strand of mature mRNA.

Answers to end of Chapter 4 test

1 B

2 C

3 B

4 C

- 5
- The cell cycle controls how quickly cells divide.
 - Uncontrollable cell division can form tumours.
 - Tumours can obstruct organs/stop organs working properly.
 - Metastasis/malignant tumours can lead to cancer.
- 6
- Blood groups have multiple alleles/alleles I^A , I^B and i .
 - Parents are heterozygous.
 - Can both pass on a recessive/ i allele to form a child with blood group O.
 - Can both pass on a dominant allele/both I^A and I^B are passed on to form a child with blood group AB.

Accept correct answers in the form of an annotated Punnett Square.

Maximum of 2 marks if incorrect genotypic notation is used.

- 7
- Prokaryotic chromosomes are circular, whereas eukaryotic chromosomes are linear.
 - Prokaryotic chromosomes are naked/not associated with histone proteins, whereas eukaryotic chromosomes are associated with histone proteins.
 - Prokaryotic chromosomes are singular in a cell, whereas eukaryotic chromosomes are multiple.
 - Prokaryotic chromosomes are free in the cytoplasm, whereas eukaryotic chromosomes are enclosed in a membrane/nucleus.
- 8
- There is a pair of sex chromosomes / X and Y chromosomes;
 - X and Y sperm are produced in equal numbers;
 - Egg is X and if fertilized by X sperm leads to a female child; Egg is X and if fertilized by Y sperm leads to a male child;
- 9 Sex linked characteristics are those which are carried on the sex chromosomes.
- 10 B

Answers to end of Chapter 5 test

- 1 D
- 2 A
- 3 B
- 4 B
- 5 Cell/plasma membrane
- 6 A
- 7
 - Lysogenic cycle.
 - Infects immune cells/helper T-cells.
 - Viral envelope fuses with plasma membrane (of host cell).
 - Viral RNA converted to DNA by **reverse transcriptase**.
 - DNA added to host genome by **integrase**.
 - New viruses are formed by the host cell.
- 8
 - Enzyme-like properties.
 - Ability to replicate.
- 9
 - Cells found in xylem and phloem tissue are atypical.
 - Cannot divide once mature.
 - Xylem cells are dead/consist only of cell wall/are not separated from adjacent cells/have no cytoplasm/cannot carry out metabolic reactions.
 - Phloem sieve tube cells lack most organelles/have perforated ends with interconnected cytoplasm.

Answers to end of Chapter 6 test

1 B

2 B

3 C

4 B

5 B

6 B

7 D

8 B

- 9
- Cell division results in smaller cells.
 - Smaller cells have a larger surface area to volume ratio.
 - Large surface area to volume ratio allows sufficient exchange of materials/oxygen/glucose/nutrients/release of waste materials/heat to support the cell's metabolic activity

10 Sentences should clearly refer to two opposing points.

Prokaryotes	Eukaryotes
No compartmentalisation	Compartmentalisation/membrane-bound organelles
No nucleus/nucleoid/DNA free in cytoplasm	Nucleus/membrane-bound DNA
Contain plasmids	Do not contain plasmids
Have pili	Do not have pili
Can have a capsule	Never have a capsule
Have 70S ribosomes	Have 80S ribosomes
Do not contain RER/Golgi apparatus/mitochondria/chloroplasts (any other valid organelles)	Contain RER/Golgi apparatus/mitochondria/chloroplasts (any other valid organelles)

- 11
- Sterols are found in plant cell membranes.
 - They reduce membrane fluidity and permeability.

- 12** • Two models are the fluid mosaic model (FMM) and the protein sandwich model (PSM).
- The FMM was proposed by Singer–Nicholson, whereas the PSM was proposed by Davson–Danielli.
 - The FMM suggests that proteins are embedded in membranes, whereas PSM suggests that proteins are peripheral to the membrane.
 - The FMM suggests that proteins can move, whereas the PSM suggests that proteins are rigid.
- 13** • Involves the movement of water molecules.
- From a region of higher water potential/lower solute concentration to and area of lower water potential/higher solute concentration.
 - Through a partially permeable membrane.
- 14** As pressure potential increases, the pressure exerted on a solution increases/positive correlation.
- 15** Sentences should clearly refer to two opposing points for differences.

Meiosis	Mitosis
Chromosomes line up individually at one point in cell division process	
Consist of prophase/metaphase/anaphase/telophase	
Require spindle fibres to move chromosomes	
Forms four cells	Forms two cells
Cells formed are haploid	Cell formed are diploid
Cells formed are genetically varied	Cells formed are clones/genetically identical
Chromosomes line up in homologous pairs (in metaphase 1)	Chromosomes line up individually

16 A

17 A

18 C

19 Cohesion and adhesion

20 Cyclins

- 21 • ADH makes the collecting duct more permeable.
- By stimulating the formation of extra aquaporins.
 - More water is reabsorbed.
 - By osmosis.
 - So less water is lost in urine/the volume of urine is reduced.

- 22 • Are found on vesicles.
- Help transport vesicles to the correct parts of a cell.

23 Sentences should clearly refer to two opposing points for differences.

Mitochondria	Chloroplasts
Both enclosed in a double membrane	
Both have one highly folded membrane	
Membranes allow the build-up of protons/separation of enzymes	
Both have membranes containing ATP synthase	
Have two membranes	Have three membranes
A high concentration of protons builds up between the inner and outer membranes	A high concentration builds up within the thylakoid membranes
Enzymes of the Krebs cycle are contained in the matrix	Enzymes of the Calvin cycle are contained in the stroma
Membranes do not contain photosynthetic pigments/photosystems	Thylakoid membranes contain photosynthetic pigments/photosystems

Answers to end of Chapter 7 test

- 1 B
- 2 C
- 3 C
- 4 C
- 5 A
- 6 D
- 7 B
- 8 B
- 9 Dendrite and Schwann cell (accept myelin sheath) correctly labelled.
- 10
 - Animal hormones produced in glands, whereas plant growth regulators (PGRs) are produced by most plant cells.
 - Animal target cells far from site of hormone production, whereas plant target cells are usually nearby.
 - Main animal hormones are steroid and peptide, whereas plant hormones consist of five main types/simple organic molecules.
 - Animal hormones are transported by blood, whereas PGRs diffuse between cell/travel in phloem.
- 11
 - Disrupt synaptic transmission.
 - Bind to post-synaptic receptors.
 - Prevent neurotransmitters/acetylcholine from binding (to receptors on the post-synaptic membrane).
 - Cause paralysis/death.
- 12
 - Consist of steroids, peptides and ions.
 - Aid cell signalling.
 - Act as first messengers.
 - Are secreted by endocrine glands.
 - Travel in the blood/bloodstream.
 - Act on target cells/organs.

13 A

- 14 ● Epinephrine is released from adrenal glands.
- Epinephrine is a first messenger.
 - Epinephrine is a peptide hormone.
 - Epinephrine binds to a G-protein coupled receptor/GPCR/adrenergic receptor.
 - This causes a change in conformation of the G-protein.
 - This causes the G-protein to exchange GDP for GTP.
 - The G-protein is now activated and stimulates adenylyl cyclase.
 - The enzyme catalyses the synthesis of cAMP.
 - cAMP is a secondary messenger.

Accept answers that refer to adrenaline instead of epinephrine.

- 15 ● Auxin is a phytohormone/plant growth regulator/PGR/plant hormone.
- Promotes positive phototropism.
 - Promotes plant growth towards light.
 - Diffuses from the tips of shoots downwards.
 - Moves to the dark side of the shoot/moves away from light.
 - Auxin is moved by auxin efflux pumps.
 - Causes gene expression of cellulase.
 - Cellulase weakens/digests plant cell walls.
 - Allows elongation of cells.
 - Auxin causes gene expression of proton pumps/movement of protons/H⁺ ions into cell walls.
 - Protons/H⁺ ions provide the optimum pH for cellulase.

Answers to end of Chapter 8 test

1 B

2 B

3 D

4 A

5 C

6 C

7 B

8 C

9 A

10 B

11 D

12 B

13 • A change away from a norm is detected.

- A correcting action takes place.
- The norm is re-established.
- The correcting action is stopped.

14 Closed – single.

- For example, in fish – accept any valid example.
- Blood only passes through the heart once in a full circuit of the body.

Closed – double.

- For example, in humans – accept any valid example.
- Blood passes through the heart twice in a full circuit of the body.

15 Advantages

[2 marks maximum]

- Can grow larger than a single cell.
- Can better access resources.
- Can resist predators.

Disadvantages

[2 marks maximum]

- Restricted movement of cells.
- More difficult for individual cells to access nutrients.
- More difficult for individual cells to excrete waste.

16 A

17 A

18 B

19 B

20 A

- 21 • The Bohr effect is a shift in the oxygen dissociation curve (of hemoglobin) to the right.
- Clearly labelled oxygen dissociation curve showing the Bohr shift (this should include correct axis labels: percentage saturation of hemoglobin and partial pressure of oxygen).
 - Correct S-shaped oxygen dissociation curve.
 - The Bohr effect occurs when there is an increase in the partial pressure of carbon dioxide.
 - Carbon dioxide dissolves in the blood to form hydrogen/ H^+ ions.
 - Carbon dioxide causes more acidic/a decrease in pH of blood.
 - This changes the shape of hemoglobin.
 - Reducing its affinity with oxygen.

Answers to end of Chapter 9 test

1 C

2 C

3 Four points from:

- Locomotion is the movement of an organism from one location or place to another.
- Running/walking/flying /swimming/jumping is an example of locomotion.
- Movement is the ability of an organism to change position or place.
- Movement includes locomotion.
- Leaves/flowers turn towards the sun/amphibians catching insects with their tongue are examples of movement (or other suitable example).

4 Titin

5 Muscles are attached to the inside of an exoskeleton but to the outside of an endoskeleton.

6 Ligament attaches bones to bone/Tendon attaches a muscle to a bone.

7 Ball and socket allows circular motion/hinge joint allows movement in one plane only

8 Muscles that work in pairs. When one contracts to cause a movement the other relaxes.
And vice versa

9 Dark grey = myosin. Fine line = actin

10 Calcium ions are released from the sarcoplasmic reticulum when an action potential arrives. They bind to the actin filaments causing troponin and tropomyosin to change shape and expose binding sites on myosin.

Answers to end of Chapter 10 test

- 1 D
- 2 A
- 3 C
- 4 Protein/glycoprotein/carbohydrate
- 5 Three from: Coral reefs/soil microorganisms/plants. *Any other valid answer.*
- 6 Antibiotics only affect prokaryotic cell metabolism, not eukaryotic cells in which viruses are found.
- 7
 - a RNA.
 - b T-helper cells/lymphocytes.
 - c
 - In the early stages, some T-cells remain active so there are no symptoms.
 - Over time more T-cells are destroyed.
 - Eventually the person has insufficient T-cells to fight infections and symptoms develop.
 - d
 - Encourage/educate about the use of condoms.
 - To prevent transmission from bodily fluids exchanged during unprotected sex.
 - Provide drug users with sterile needles/educate about the use of unsterilised needles.
 - To prevent transmission from blood on shared needles.
 - Screen donated blood.
 - To prevent transmission through blood transfusions.
 - medications to help prevent transmission to unborn babies from HIV positive mothers.
- 8
 - Phagocytes have a non-specific response to pathogens/infection/disease.
 - Phagocytes move towards pathogens by chemotaxis/by detecting chemicals released by pathogens.
 - Phagocytes engulf pathogens by endocytosis.
 - Phagocytes digest pathogens using hydrolytic enzymes.
 - Lymphocytes have a specific response to pathogens/infection/disease.
 - Lymphocytes can produce antibodies specific to the antigens (of the pathogen).
 - Antibodies destroy pathogens.
 - Lymphocytes can produce memory cells to confer immunity.

➤ **9** B

10 C

11 C

- 12** • Blood group AB.
- Their blood plasma does not contain anti-A or anti-B antibodies.
 - They can receive all blood types without risk of agglutination of red blood cells.

Answers to end of Chapter 11 test

- 1 D
- 2 B
- 3 C
- 4 A group of organisms that share common characteristics and can interbreed to produce fertile offspring.
- 5 Domain, Kingdom, Phylum, Class, Order, Family, Genus, Species
- 6
 - In natural selection, the environment determines which organisms reproduce whereas humans determine this in artificial selection.
 - In natural selection, traits passed on to offspring provide a survival/reproductive advantage whereas traits passed on in artificial selection are desired by/useful to humans/may not provide a survival/reproductive advantage.
- 7
 - Binomial system.
 - Organism name consists of genus and species.
 - Represents hierarchy of taxa/evolutionary relationships.
 - Used internationally.
 - Allows international understanding despite varying common names in different languages.
- 8
 - Geographical – organisms are physically separated from reproducing.
 - Behavioural – organisms' courtship rituals differ, preventing them from reproducing.
 - Temporal – organisms' are active at different times, so cannot meet to reproduce.
- 9
 - A fundamental niche is the potential mode of existence of organisms of a species given their adaptations.
 - A realised niche is the actual mode of existence of organisms of a species in a particular ecosystem.
 - (A realised niche may result from) competition with species with similar niches.
- 10
 - Indicates level of biodiversity in an area.
 - Takes into account species richness and species evenness.
 - Higher numbers indicate higher biodiversity.

11	Aspect of the theory of evolution	Letter of matching statement
	Some variations are inherited	C
	There is variation in all populations	B
	Natural populations overproduce offspring	A

12 Example key shown below. Others are possible. No marks awarded for features that mention size without including relative proportions.

[8]

1	has two toes has more than two toes	deer 2
2	has three toes has more than three toes	3 4
3	toes are 'webbed' and linked by skin toes not webbed	duck turkey
4	four toes present five toes present	5 6
5	claws present at the end of the toes no claws on the toes	coyote bobcat
6	five toes are 'webbed' five toes are not webbed	beaver 7
7	instep clearly visible no instep present	black bear raccoon

13 B

14 C

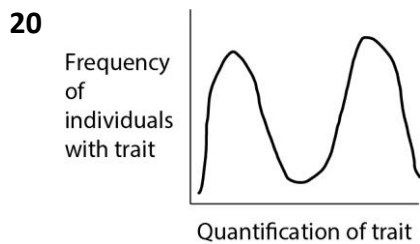
15 A

16 B

17 All the genes and alleles in an interbreeding population.

- 18**
- Gradual speciation is called gradualism, whereas abrupt is called punctuated equilibrium.
 - Gradualism involves slow change in traits, whereas punctuated equilibrium involves rapid change in traits.
 - Gradualism occurs constantly whereas, punctuated equilibrium involves long periods of stasis.

- 19** • A cladogram is a diagram/tree representing evolutionary relationships.
- DNA sequence differences accumulate gradually over time in diverging populations/species.
 - DNA codes for amino acids (in proteins).
 - (So) amino acid sequence differences accumulate gradually over time in diverging populations/species (too).
 - There is a positive correlation between the number of differences between two species and their divergence from a common ancestor.
 - The more similarities in amino acid sequences between species, the closer the evolutionary relationship.



Award 1 mark for correct overall shape.

Award 1 mark for correct axis labels.

- 21** • Sexual selection results from differential reproductive success.
- Due to mate choice/intersexual selection.
 - For example, female peahens choose peacocks with elaborate tail feathers (accept any other valid example).
 - (And) competition for mates/intrasexual selection.
 - For example, the larger the male *Dryomyza anilis* fly, the more likely the chances of successfully competing for a mate (accept any other valid example).
 - Differs from natural selection in which traits that confer a survival advantage are selected for.
 - By the environment.

Allow marks for valid examples which illustrate the points above.

- 22** • Polyploidy is when a cell contains more than two sets of chromosomes.
- Can occur due to lack of cell division after meiosis/fusion of diploid gametes.
 - Fusion of haploid gamete/gamete from a diploid organism with a diploid gamete/gamete from a tetraploid organism results in triploid offspring.
 - Triploids are often sterile.
 - As odd number of chromosomes cannot separate equally during meiosis.
 - If a diploid organism produces tetraploid offspring, speciation is likely to occur.

Answers to end of Chapter 12 test

1 C

2 A

3 B

4 A

5 D

6 D

7 C

8 A

9 D

10 C

11 C

12 C

13 The number of organisms of a particular species in the same area at the same time.

14 a Caterpillar/beetle/wood mouse/rabbit

b Fox

c 4

- d
- Producer on bottom.
 - Correct shape and number of trophic levels.

15

- Provides energy.

- For photosynthesis.
- Is converted into chemical energy.
- Chemical energy can be passed along food chains.

16

- Energy is lost to the food chain at each trophic level.

- As heat.
- Energy is lost in dead organic material.
- There is insufficient energy to support further trophic levels.

17

- Correct identification of 3.84 as critical value.

- 5.22 greater than 3.84.
- So reject the null hypothesis.

18 • Mark–release–recapture.

- Trap a sample of the population.
- Valid example of trapping, e.g. pitfall traps/netting/Longworth trap.
- Trapping must not harm the organisms.
- Record the number of organisms sampled.
- Inconspicuously mark the sampled organisms.
- Marking must not harm the organisms.
- Return the sample to the environment in which they were found.
- Wait for a period of time which allows organisms to disperse and interact freely with the rest of their population.
- Trap a second sample of the population.
- Record the number of marked and unmarked individuals in the second sample.
- Calculate the population size using the Lincoln index.

$$P = \frac{M \times N}{R}.$$

- Assumes little immigration or emigration.
- Should be carried out within the time of one life cycle of the organism.

➤ **19 B**

20 D

21 C

22 A

23 B

24 D

25 a Two from:

- sample captured, marked and released
- ratio of marked individuals in a second sample determined
- equals ratio of marked sample to entire population or use Lincoln index

b One from:

- low level of immigration/emigration between sampling times
- distribution not affected by capture or marking
- reproduction not affected by the capture

- 26 • Chemosynthetic autotrophs use energy from chemical reactions to produce organic compounds from inorganic substances.
- Photosynthetic autotrophs use energy from sunlight to produce organic compounds from inorganic substances.