Chapter One

Variation in population size	Population size may vary as a result of • the effect of abiotic factors • interactions between organisms: interspecific and intraspecific competition and predation.
Human populations	Population size and structure, population growth rate, age-population pyramids, survival rates and life expectancy. **Candidates should be able to** • interpret growth curves, survival curves and age-population pyramids • calculate population growth rates from data on birth rate and death rate. • relate changes in the size and structure of human populations to different stages in demographic transition.

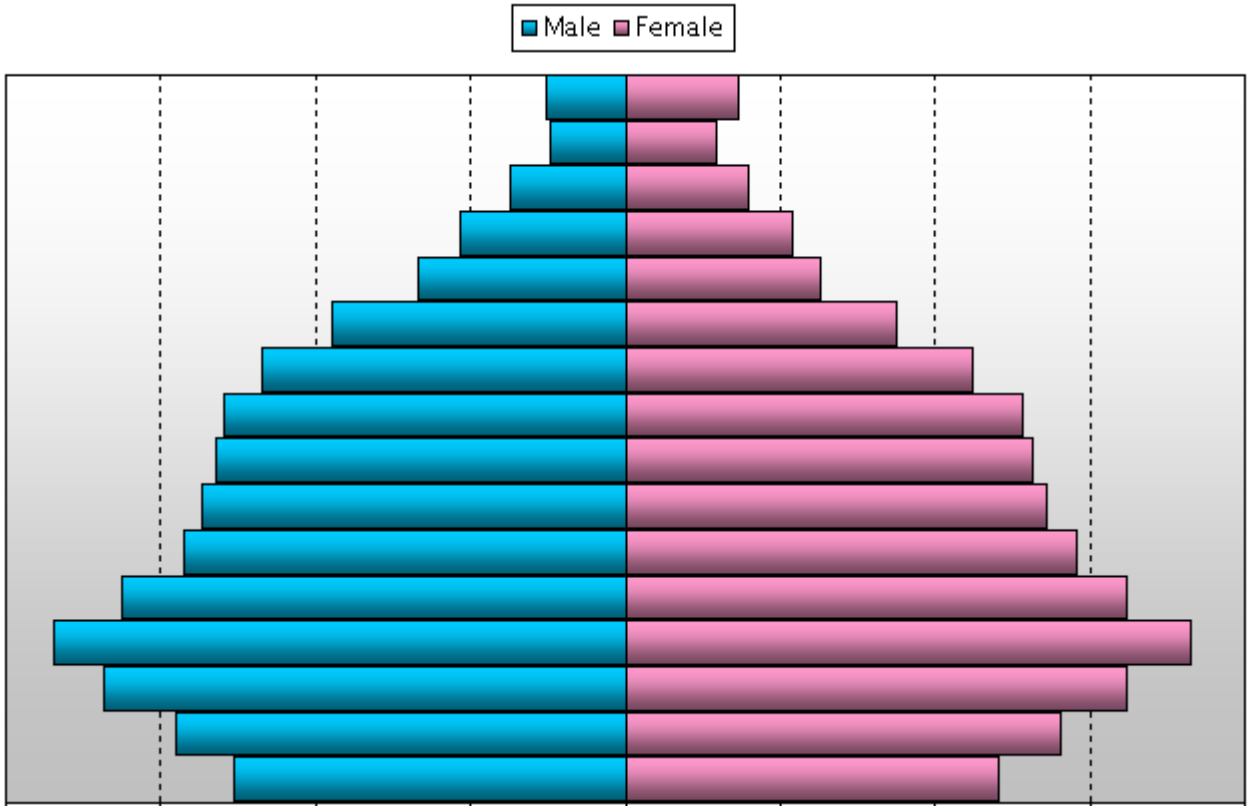
Variation in Population Size

- **Limiting factors →**
- Mineral ions.
- Light.
- Temperature.
- Oxygen.
- Food.

- **Abiotic factors →**
- **Temperature –** optimum temperatures needed for the best survival.
- **Light –** ultimate source of energy.
- **pH –** optimum pH for enzymes to work to full potential.
- **Water –** in low water areas, only species well adapted to dry conditions survive.
- **Humidity –** the more humid, the slower the transpiration rate.

Human Populations

- **Decreasing population →**
- Lower birth rate (narrow base) and low mortality rate so there are more elderly people (wider apex).



ATP

- All living organisms require energy to survive.

- Energy can take many forms such as light and kinetic.
- Energy cannot be created nor destroyed.
- It is measured in joules (J).
- It can change from one form to another.

- **Why energy is needed →**
- **Metabolism –** all reactions in the body need energy.
- **Movement –** for in and out of the body itself.
- **Active transport –** ions and molecules need to be transported against the concentration gradient.
- **Repair and division.**
- **Production of substances –** such as enzymes and hormones.
- **Maintenance of body temperature –** mammals and birds are endothermic and need energy to replace that lost as heat to the environment.

Light-Dependent Reaction

- Light photons are absorbed by photosystem II in the thylakoid membrane.
- Photolysis occurs in the thylakoid space – this splits water into oxygen, protons and electrons.
- **Oxygen is a by-product.**
- The electrons are taken up by photosystem II – these electrons are excited by the light photons and reach a higher energy level.
- Via a series of redox reactions, the electrons pass along electron carriers. These electrons carries form a transfer chain in the membrane.
- Since electrons lose energy along the chain, they are re-energised in photosystem I.
- The energy released is used to combine ADP and an inorganic phosphate to produce ATP in ATP synthase.
- Protons produced in photolysis and excited electrons are taken up by ATP synthase and are used to reduce NADP to NADPH.
- NADPH goes on into the light-independent reaction.

Factors Affecting Photosynthesis

- **Slowest reaction determines the overall rate.**

- **Light intensity →**
- When light is the limiting factor, photosynthesis is directly proportional to light intensity.
- As light intensity increases, the volume of oxygen produced and carbon dioxide absorbed will increase until its balanced – compensation point (no net exchange of gases into or out of the plant).
- When increasing light intensity has no effect, it is not the limiting factor.

- **Carbon dioxide →**
- 0.1% is the optimum concentration for photosynthesis.
- Carbon dioxide concentration affects enzyme activity.

- **Temperature →**
- From 0-25˚c → rate of photosynthesis doubles for each 10˚c.
- 25˚c is the optimum temperature, after this, the rate decreases due to enzymes becoming denatured.
- Photosynthesis is not purely photochemical, if it was, it wouldn't be affected by temperature.

Krebs Cycle

- **Significance of the Krebs cycle→**

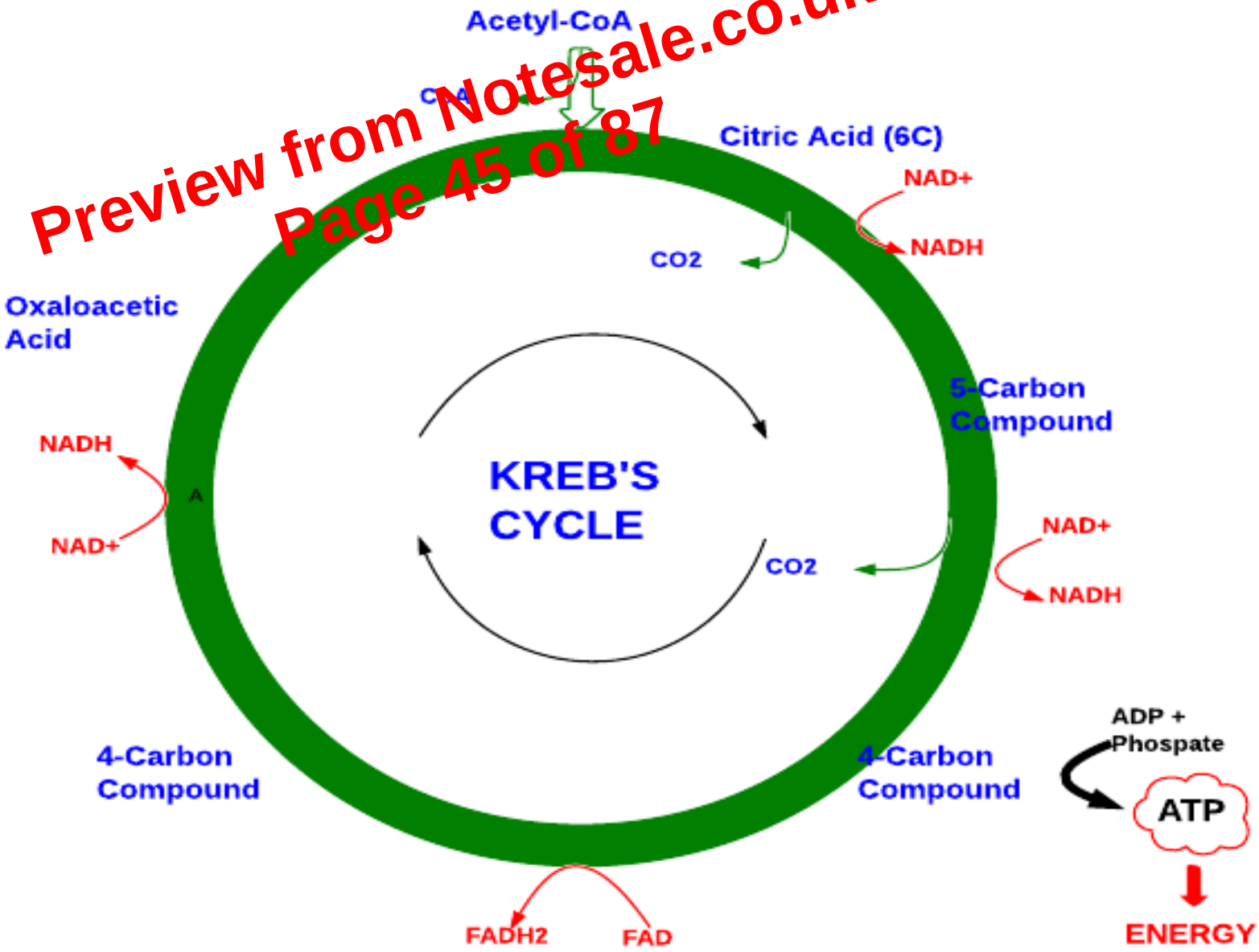
❖ It breaks down macromolecules into smaller ones (pyruvate into carbon dioxide).

❖ It produces hydrogen atoms carried by NAD to the electron transport chain for oxidative phosphorylation. This leads to the production of ATP for metabolic energy in the cell.

❖ It regenerates the four-carbon molecule that combines with acetylcoenzyme A.

❖ It is a source of intermediate compounds used by cells to manufacture substances such as fatty acids and chlorophyll.

Krebs Cycle



Agricultural Ecosystems

- **To remove/suppress unwanted species and to maximise growth requires additional energy input.**
- Food – farmers expend energy as they work – comes from the food they eat.
- Fossil fuels – used to plough, harvest and transport crops, house, feed and transport livestock.

- **Natural ecosystems have low productivity – additional energy increases productivity in agricultural ecosystems – reduces effect of limiting factors.**

- Energy used to exclude other species gives crops less competition.
- Ground is covered almost exclusively by crop.
- Fertilisers provide ions and pesticides destroy pests and prevent disease.

Carbon Cycle

- **Nutrient cycle sequence →**
- Nutrient taken up by producers as simple, inorganic molecules.
- Producer incorporates nutrient into complex organic molecules.
- Producer is eaten – consumer takes in nutrient.
- Passes along food chain.
- Producers and consumers die – complex molecules are broken down by saprobiotic microorganisms (decomposers).
- Nutrient is released in its simplest form.

- **Increase in carbon dioxide levels →**
- Combustion of fossil fuels – coal, oil and peat.
- Deforestation – removed enormous amounts of photosynthesising biomass.

Greenhouse Effect & Global Warming

- **Greenhouse effect →**
- Some radiation reaching the surface is reflected back as heat and lost in space.
- Some is radiated back to earth by clouds and greenhouse gases.
- The gases trap heat close to the surface.

- **Greenhouse gases →**
- Carbon dioxide – remains in the atmosphere for a long time (100 years).
- 50-70% of global warming is due to carbon dioxide.
- Methane, another greenhouse gas, is produced when microorganisms break down organic molecules.
- **This occurs when →**
- Decomposers break down dead remains.
- Microorganisms in the intestines of primary consumers digest eaten food.

- **Global warming →**
- Mean global temperature increased by 0.6˚c since 1900.
- Concentration of carbon dioxide has risen from 270ppm before the industrial revolution to 370ppm.
- **Consequences →**
- Melting of polar ice caps could cause extinction of some wild plants and animals.
- Rise in sea levels due to thermal expansion of ocean could flood low-lying land.
- Higher temperature and less rainfall could lead to failure of crops.
- Greater rainfall and intense storms would occur in some areas due to disturbance of climate patterns.
- Life-cycles and populations of insect pests would alter as they adapt to changed conditions.

Nitrogen Cycle

- **Ammonification →**
- Production of ammonia from organic ammonium-containing compounds – urea, proteins, nucleic acids and vitamins.
- Saprobiotic microorganisms feed on these materials, releasing ammonia which then forms ammonium ions in the soil.

- **Nitrification →**
- Some bacteria obtain energy from chemical reactions.
- Conversion of ammonium ions to nitrate ions – oxidation reaction releases energy – carried out by nitrifying bacteria.
- Nitrifying bacteria need oxygen – need soil with air spaces.
- To raise productivity, farmers keep soil structure light and well aerated by ploughing.
- **Two stages →**

1. Oxidation of ammonium to nitrite.
2. Oxidation of nitrite to nitrate.

Selection

- **Selection →** organisms that are better adapted to their environment survive and breed, while those that are less well adapted fail to do so.

- **Differences between reproductive success affects allele frequency →**
- All organisms produce more offspring than can be supported.
- Despite this, most population sizes remain constant.
- Hence, intraspecific competition arises.
- Some individuals will possess combinations of alleles that make them fitter to survive.
- These are more likely to obtain available resources, survive and reproduce.
- Only those that successfully reproduce will pass on their alleles.
- New individuals inherit “advantageous” alleles.
- Over many generations, allele frequency of “advantageous” alleles increase while “non-advantageous” alleles decrease.

- **“Advantageous” alleles depend upon environmental conditions.**

- **Direction selection →** favours individuals that vary in one direction from the mean of the population – this changes characteristics.
- **Stabilising selection →** favours average individuals and preserves characteristics.

Speciation

- **Speciation** → the evolution of new species from existing species.

- If two populations become separated, the flow of alleles between them may cease.
- The environmental factors that each group encounters may differ.
- In time, the gene pools may become so different that, even if reunited, they would be incapable of successfully breeding with each other.

- **Geographical isolation** →
- Individuals of species X form a single gene pool an freely interbreed.
- Climate changes over centuries lead to drier conditions which reduce the forest area and separate it into two regions many kilometres apart.
- Further climate change changes cause forest A to become much colder and wetter and forest B to become warmer and drier.
- In A, phenotypes are selected to survive colder and wetter conditions.
- In B, phenotypes are selected to survive warmer and drier conditions.
- Type and frequency of alleles in gene pools of each groups of species X become increasingly different.
- In time, the gene pools become so different that the two groups become separate species.