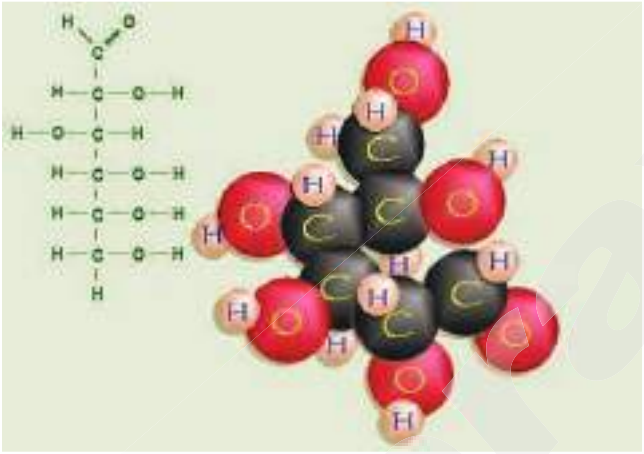
2. Biological Molecules

Carbohydrates:

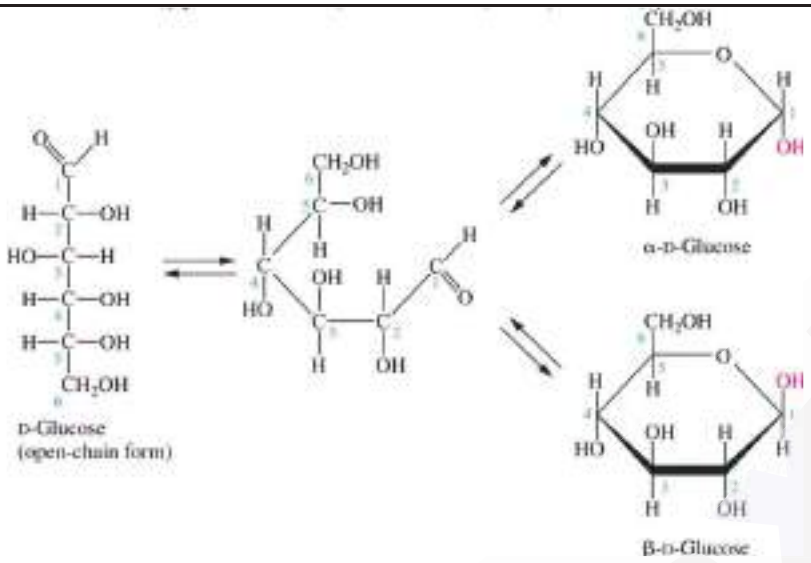
- **Sugar polymers**
- Molecules contain **C, H, O** atoms
- H atoms are twice as many as C or O atoms ($C_6H_{12}O_6$)

Carbohydrates - Monosaccharides, disaccharides



Monosaccharides

- The simplest carbohydrates
- They are sugar: C = 3 = triose C = 4 = tetrose C = 5 = pentose C = 6 = hexose
- Examples of hexose sugars: glucose, fructose, galactose ($C_6H_{12}0_6$)
- Molecules often have the form of a ring, made up of some C atoms and one O atom.
- Glucose molecules has 2 forms: α-glucose and β-glucose.

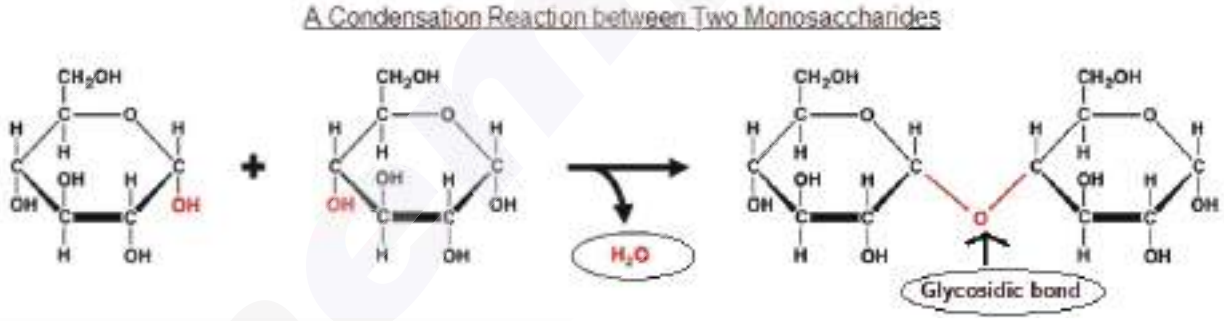


Disaccharides

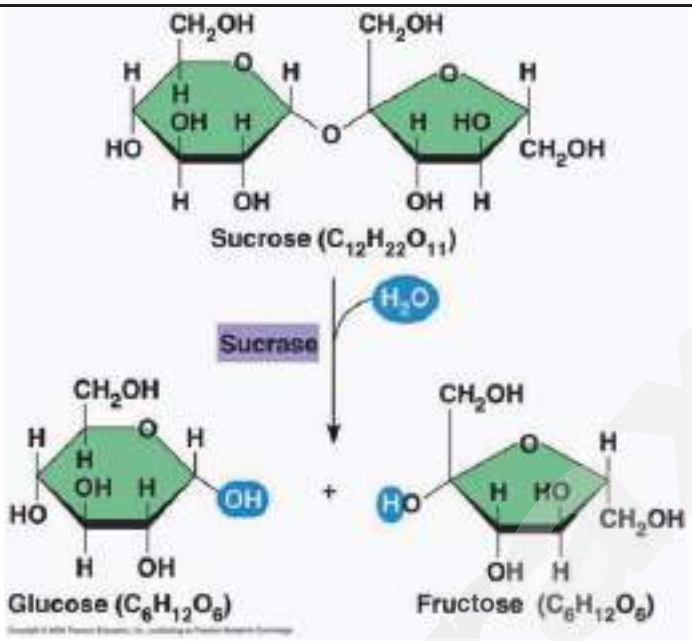
- Different disaccharides can be formed by linking different monosaccharides. The bond that joins them together = **glycosidic bond.**

Disaccharide	Monosaccharides
Maltose	Glucose + Glucose
Lactose	Glucose + Galactose
Sucrose	Glucose + Fructose

- **Condensation reactions** (dehydration): 2 monosaccharides covalently joined; H_20 is formed.



- **Hydrolysis reaction** (splitting by water): disaccharides are split into 2 monosaccharides by breaking the glycosidic bond; a molecule of H_20 is added.
- All monosaccharides and some disaccharides are **reducing sugars** (reduce blue Benedict's solution to produce an orange-red precipitate). Sucrose is a **non-reducing sugar**.



Carbohydrates – Polysaccharides

- Molecules contain hundreds/thousands of **monosaccharides** linked into long chains.
  - Molecules are enormous --> the majority do not dissolve in water --> good for **storing energy** (**starch** and **glycogen**) or for **forming strong structures** (**cellulose**).

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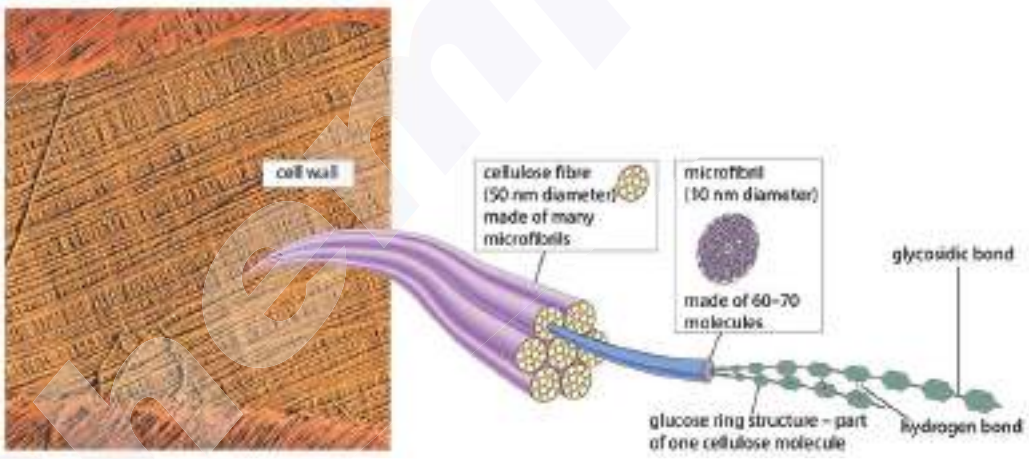
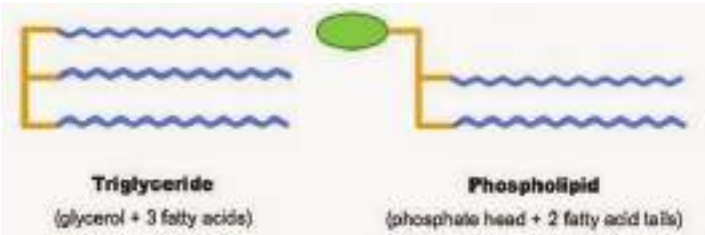
	Amylose	Amylopectin	Glycogen	Cellulose
Source	Plant	Plant	Animal	Plant
Subunit	α-glucose	α-glucose	α-glucose	β-glucose
Bonds (glycosidic bonds)	α-1,4	α-1,4- α-1,6-	α-1,4- α-1,6-	β-1,4-
Branches	No	Yes	Yes	No
Illustration				

- H bonds between chains --> very strong **microfibrils** --> cell wall will not break easily if the plant cell absorbs water; difficult to digest (few organisms have enzyme that can break the β 1-4 bonds).

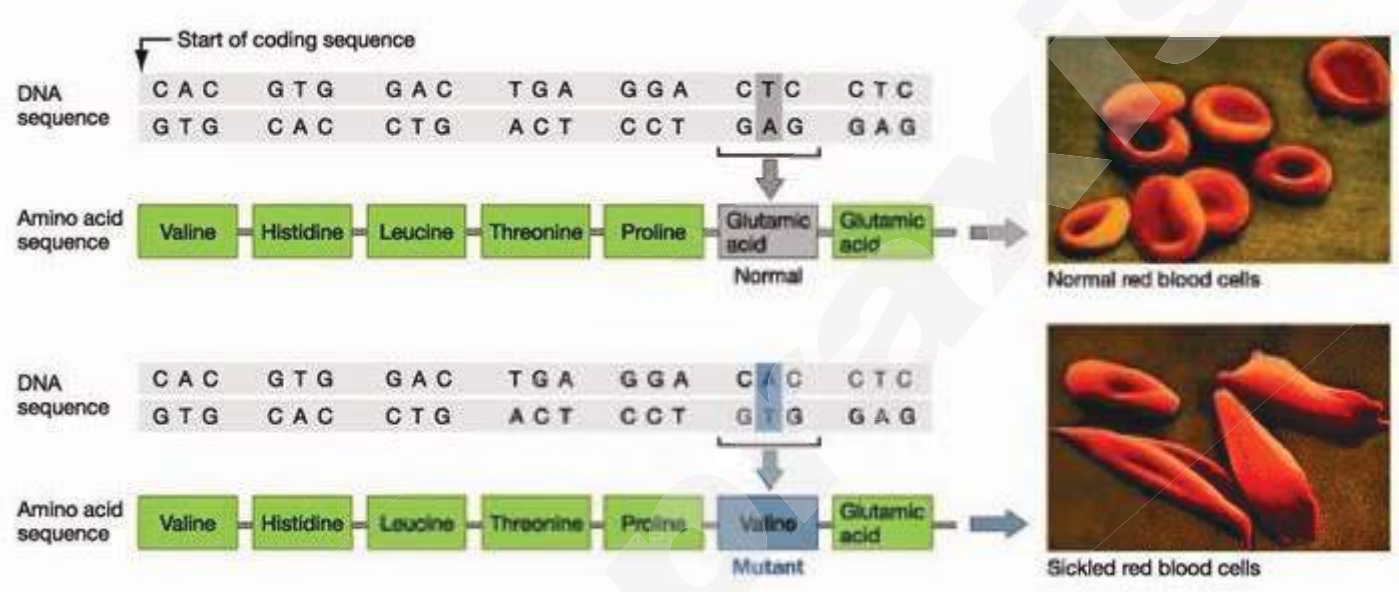


Lipids:
- Include **triglycerides** + **phospholipids**.
- Molecules contain **C, H, O** atoms
- Very small proportion of O.
- **Insoluble** in water.



Sickle Cell Anaemia

An example of a mutation is a change in the gene that codes for one of the polypeptides in a Hb molecule. In the genetic disease **sickle cell anaemia**, the gene that codes for the β polypeptide has the base **T** where it should have the base **A**. This means that one triplet is different, so a different amino acid is used when the polypeptide chain is constructed on a ribosome.



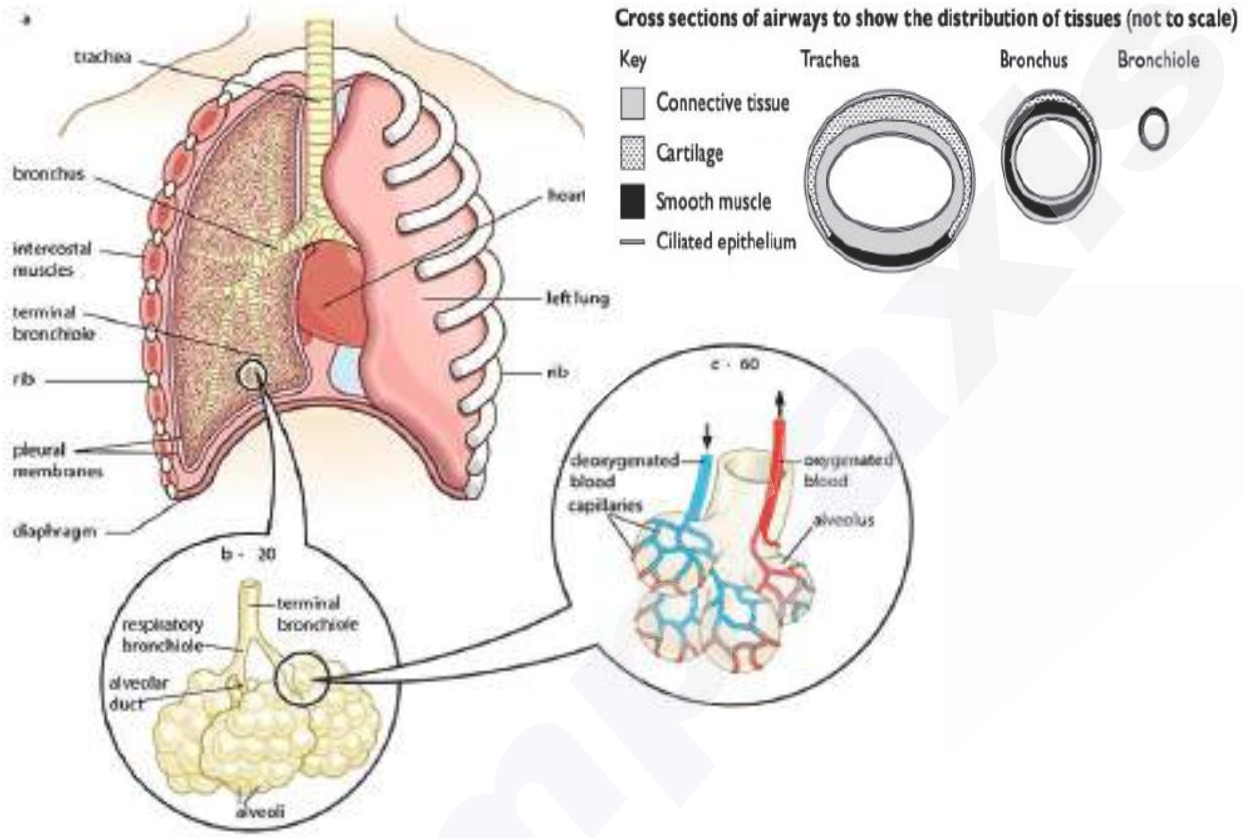
These amino acids are on the outside of the Hb molecule when it takes up its tertiary and quaternary shapes.

- **Glutamic acid** is a hydrophilic amino acid. It interacts with water molecules, helping to make the haemoglobin molecule soluble.
- **Valine** is a hydrophobic amino acid. It does not interact with water molecules, making the haemoglobin molecule less soluble.

***Q: Explain how a single change in the DNA triplet for the sixth amino acid of the gene coding for the β chain leads to the production of a different amino acid sequence.**

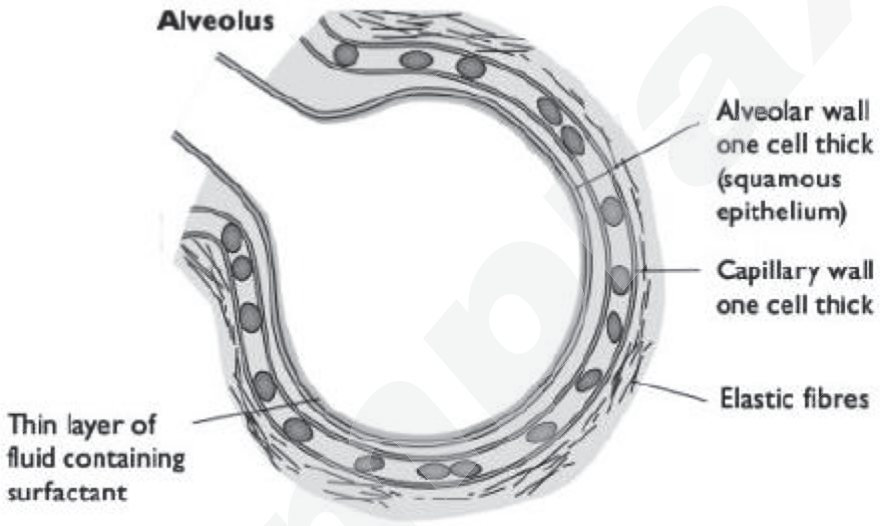
9. Gas Exchange

The Gas Exchange System



Airway	Number	Approximate diameter	Cartilage	Goblet cells	Smooth muscle	Cilia	Site of gas exchange
trachea	1	1.8 cm	yes	yes	yes	yes	no
bronchus	2	1.2 cm	yes	yes	yes	yes	no
terminal bronchiole	48 000	1.0 mm	no	no	yes	yes	no
respiratory bronchiole	300 000	0.5 mm	no	no	no	a few	no
alveolar duct	9×10^6	400 µm	no	no	no	no	yes
alveoli	3×10^9	250 µm	no	no	no	no	yes

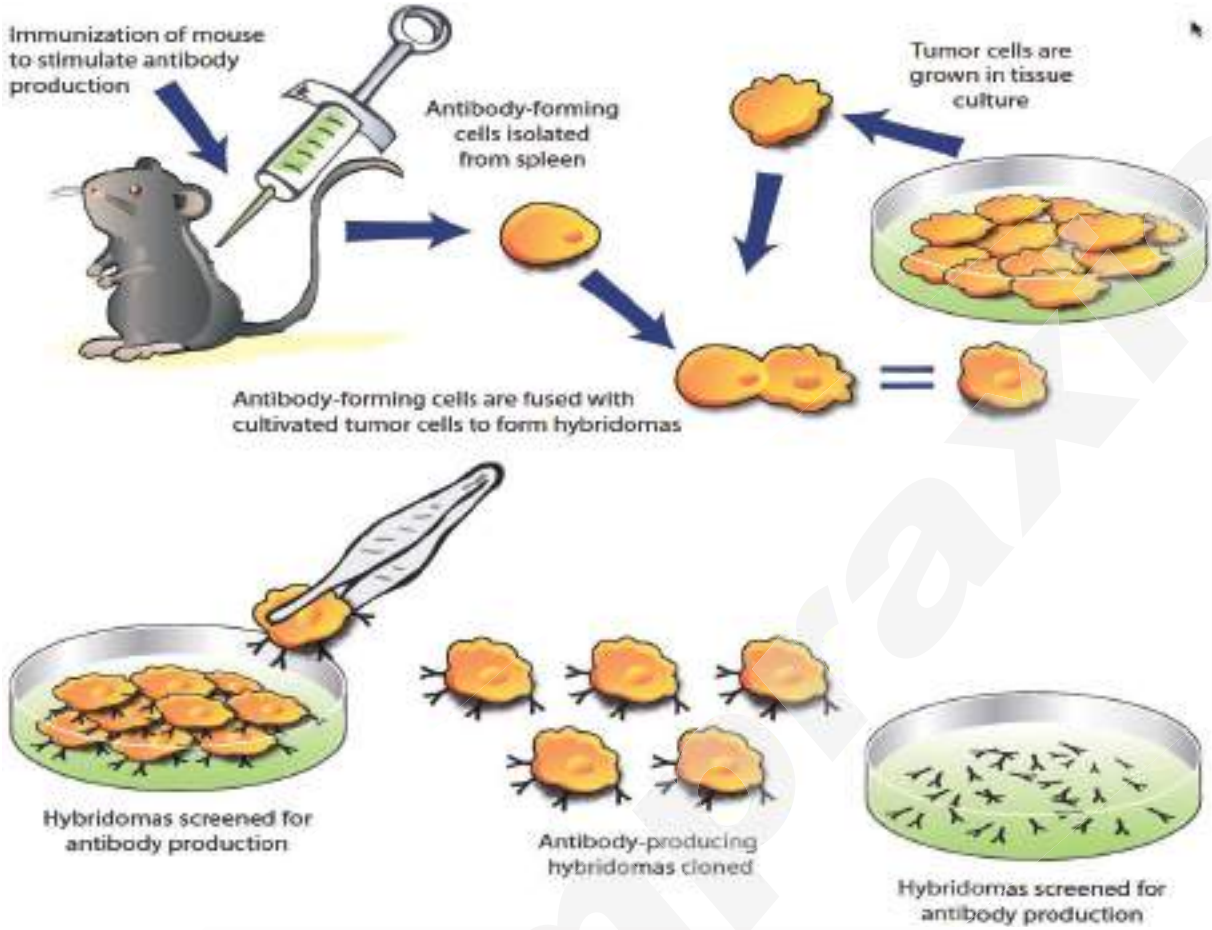
- **Cartilage** – provides support and prevents the tubes collapsing when the air pressure inside them is low.
  C-shaped rings of cartilage in **trachea**
  Irregular blocks of cartilage in **bronchus**
- **Cillated epithelium** – sweep mucus upwards towards the mouth, helping to prevent dust particles and bacteria reaching the lungs.
- **Goblet cells** – secrete mucus, which traps dust particles and bacteria.
- **Smooth muscle** – When it contracts, reduces the diameter of the tubes. During exercise it relaxes, widening the tubes so more air can reach the lungs.
- **Elastic fibres** – stretch to allow the alveoli and airways to expand and recoil to reduce the volume of alveoli and expel air out of the lungs.



***Q: Explain how alveoli are adapted for gas exchange.**

ignore moist
correct ref. to diffusion of, carbon dioxide / oxygen ; **A** absorb / lose / AW
(many alveoli) large surface area ;
surrounded by, (many) capillaries / capillary network / AW ;
short diffusion distance (between air and blood) ;
blood maintains concentration gradient ;
epithelium / alveolar wall / AW, thin / squamous ; **A** alveolus one cell thick
A alveolus has a thin wall
R cell wall e.g. alveolar cell wall is thin
idea that very little between, epithelium and endothelium / AW ;
e.g. alveolus and capillary are close together

Monoclonal antibodies



***Q: Outline how monoclonal antibodies are produced.**

1 antigen, introduced / AW, into, (small) mammal ; **A** named small mammal
2 B-lymphocytes / B cells / plasma cells / splenocytes / antibody-producing lymphocytes, are taken / are isolated (from the spleen / lymph nodes) ;
3 (these) cells are fused / AW, with, myeloma / cancer, cells ;
4 hybridoma cells / hybridomas, formed ; **R** hybridised cells / hybrid cells
5 hybridoma cell, is cloned / AW ;
6 screening / testing, for hybridoma that produces desired antibody ;
7 *ref. to* scaling up / large-scale production / grow in a fermenter ;
8 AVP ; e.g.
fusion using, fusogen / polyethylene glycol / PEG / electric current (electrofusion) / (Sendai) virus
HAT medium, for, hybridoma growth / inhibiting myeloma growth
humanisation of monoclonal antibody

Application of monoclonal antibodies

Diagnosis	- Can be used to locate the position of blood clots in the body - A radioactive chemical that produces gamma radiation is attached to each antibody molecule to make radioactively labeled antibodies - Bind to fibrin with which they come into contact - A gamma ray camera is used to detect the exact position - Other: detect cancer cells
Treatment	- Trastuzumab → treat some breast cancers → binds to a receptor protein that is produced in abnormal quantities in the cell surface membrane of cancer cells→ marks them out for destruction by the immune system - Ipilimumab → therapy for melanoma (skin cancer) - Infliximab → treat rheumatoid arthritis (autoimmune disease) - Rituximab → control overproduction of B-lymphocytes (leukaemias)

***Q: Suggest the advantages of using monoclonal antibodies in diagnosis of disease.**

1 monoclonal antibodies used all have the same specificity ;
R 'are specific' unqualified
2 detect only one, antigen / epitope ;
3 can distinguish between different, pathogens / strains of, pathogens ; **A** types of cancer cells
4 can be, labelled / tagged / marked / AW ; e.g. with fluorescent label
5 monoclonal antibodies can detect location of, tissues expressing antigen / cancer cells / blood clots ; **A** *idea of* locating areas of infection
6 fast(er) (diagnosis) ;
7 can detect antibody levels (e.g. HIV) ;
8 AVP ; e.g. some pathogens cannot be cultured
I *ref. to* cost