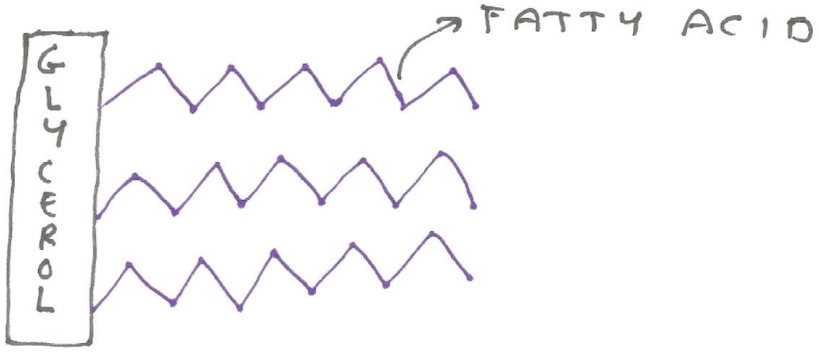
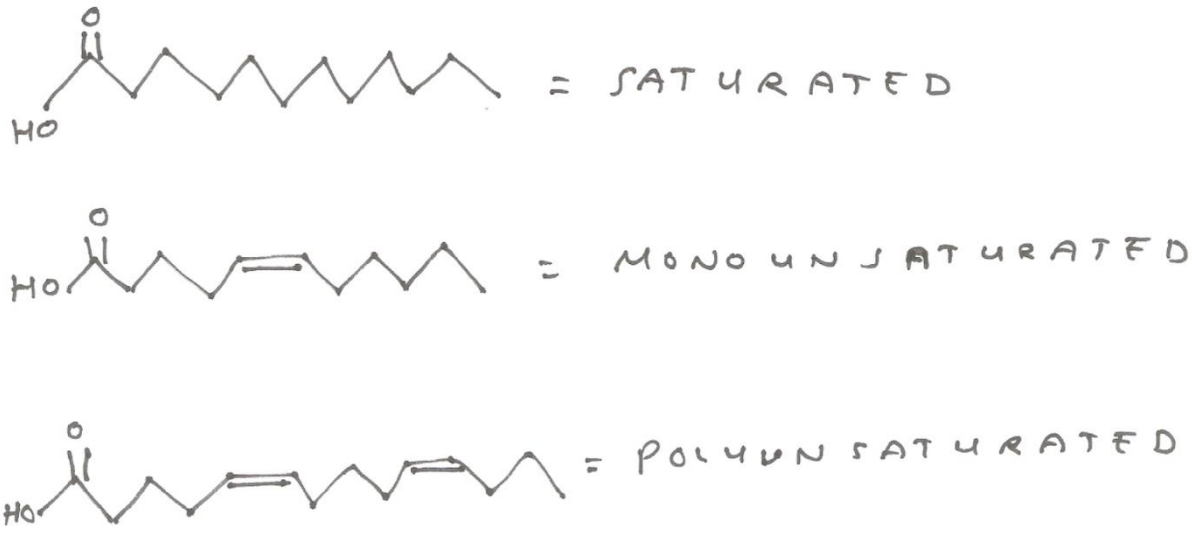
Lesson 6 – Triglycerides



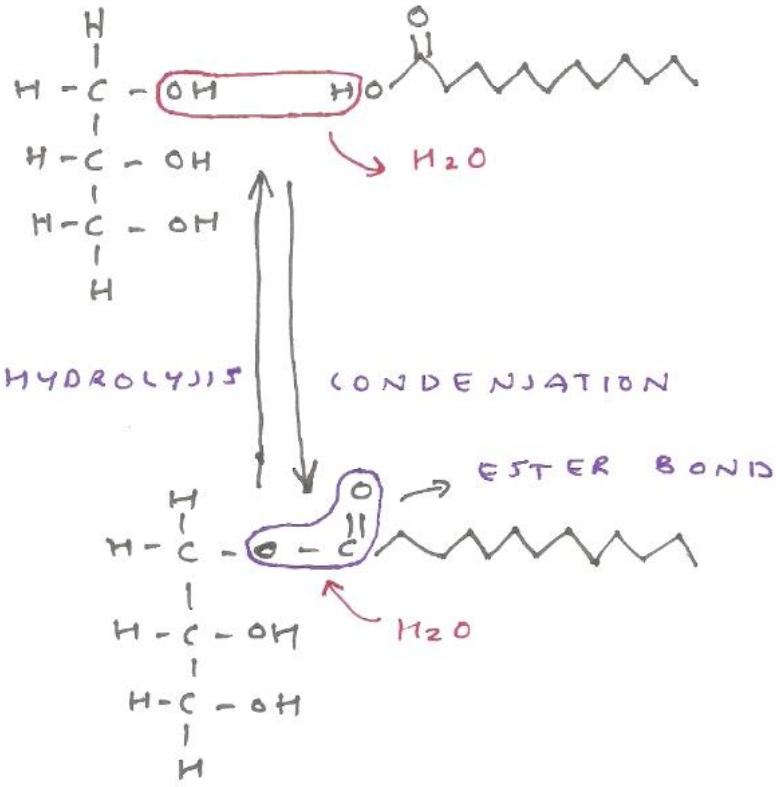
Lipids (fats) are examples of **macromolecules**; they are <u>not</u> polymers.
Triglycerides are lipids that consist of **glycerol** and **fatty acids**; there are many different types of fatty acid.



Fatty acids consist of a **carboxyl group** attached to a **hydrocarbon tail**; this can be 2 to 20 carbons long. The carboxyl group ionises into H^+ and a $–COO^-$ group.

A **saturated** fatty acid is one where there are no C=C double bonds. A single C=C bond within the hydrocarbon tail makes it **monounsaturated** (e.g. linoleic acid); more than one C=C bond makes it **polyunsaturated**.

Polyunsaturated fatty acids are more fluid; this is because the C=C bonds push the molecules apart slightly. Saturated fatty acids are often solid at room temperature because they have a higher melting point (hence why animal fats are often solid).



Triglycerides form when <u>three</u> fatty acid chains can join onto one glycerol molecule; this is called **esterification**. A **condensation** reaction happens between the carboxyl group on the fatty acid and the hydroxyl group on the glycerol. The covalent bond between glycerol and a fatty acid is called an **ester bond**.

Triglycerides can be broken down via **hydrolysis** reactions in **respiration** to form **ATP** (beta-oxidation); this makes triglycerides a good **energy source**. Triglycerides can also be a source of water from respiration (i.e. camels).

The number of C-H bonds within a triglyceride means they are very rich in energy. Triglycerides are **insoluble** in water so they can be stored without affecting a cells water potential; this makes them a good **energy store** within adipose cells.

Other functions of triglycerides include:

- **Insulation** - this can be to prevent heat loss (e.g. blubber) or electrical insulation in neurones (the **myelin sheath**).
- **Buoyancy** – lipids are less dense than water so it can allow aquatic animals to float.
- **Protection** – humans have fat around internal organs (e.g. the heart and kidneys) to act as a shock absorber.

(iii) Triglycerides are a type of lipid found in milk.

Describe the structure of a triglyceride molecule.

.....

.....

.....

.....

.....

.....

..... **[3]**

(b) State **three** roles of lipids in living organisms.

1 .....

.....

2 .....

.....

3 .....

..... **[3]**

(c) Human populations with diets high in animal fats have a lower life expectancy than those with diets high in vegetable oils.

(i) Suggest **one** difference between lipids from animals and those from plants.

.....

..... **[1]**

Animal fats are thought to raise blood cholesterol levels. High blood cholesterol levels can lead to premature death.

Fig. 1.1 shows the relationship between blood cholesterol level and annual death rate per 10 000 of the population.

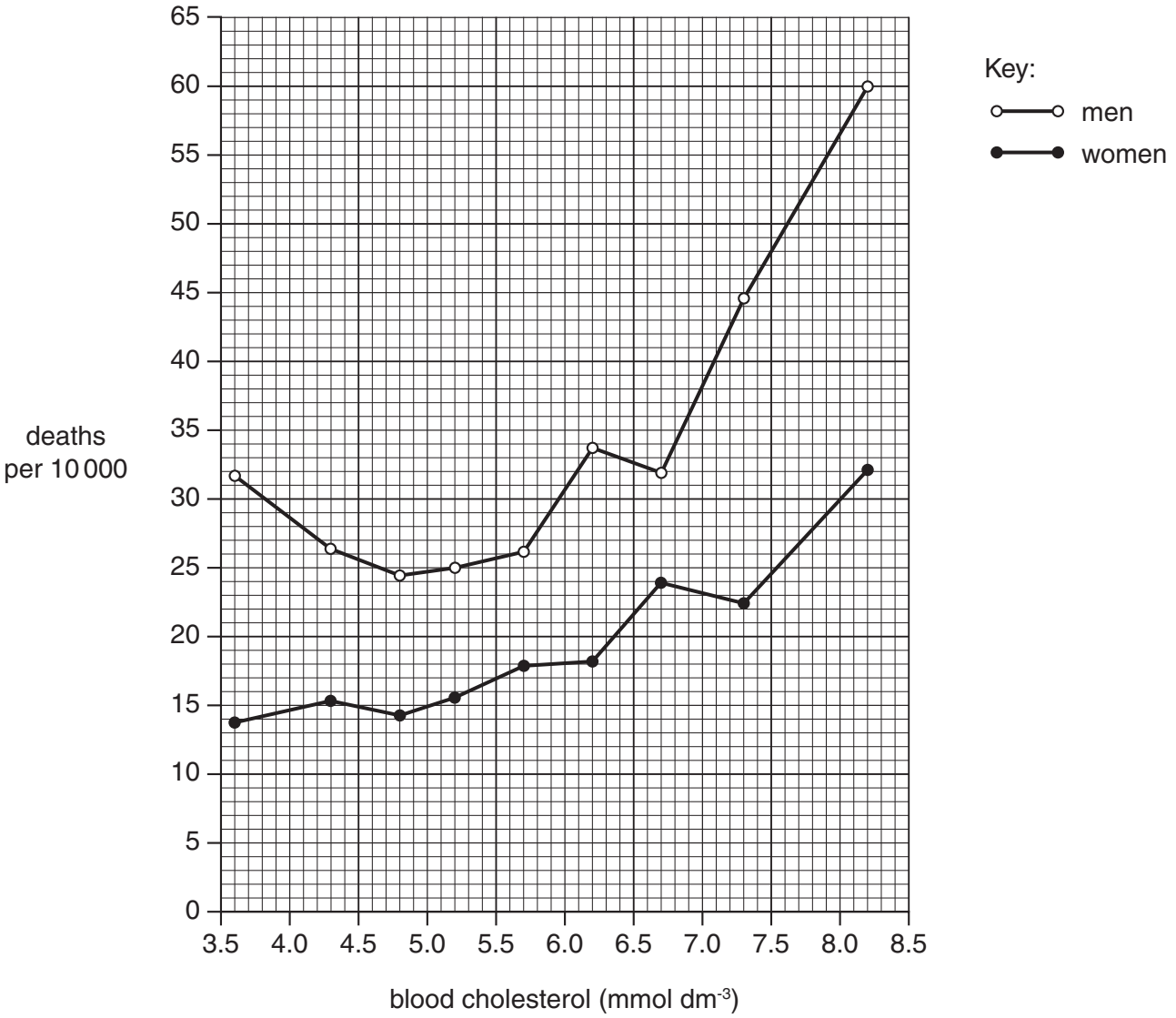


Fig. 1.1

(ii) Describe the trends shown in Fig. 1.1.

.....

.....

.....

.....

.....

.....

..... **[3]**

(iii) Increased blood cholesterol levels are associated with certain medical conditions.

Suggest **two** medical conditions that may be associated with increased blood cholesterol levels.

.....

..... **[2]**

[Total: 16]

<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th>reagent</th><th>observation</th><th>molecule</th><th>present or absent</th></tr>
<tr><td>ethanol and water</td><td>white emulsion</td><td>lipid</td><td>present</td></tr>
<tr><td>Benedict's solution</td><td>brick-red precipitate</td><td><u>reducing</u> sugar / lactose / glucose / galactose / monosaccharides</td><td>present ;</td></tr>
<tr><td>biuret I and II</td><td>lilac colour</td><td>protein / named milk protein</td><td>present ;</td></tr>
<tr><td>iodine solution</td><td>yellow / brown</td><td>starch / amylose</td><td>absent ;</td></tr>
</table>
</td><td>3</td><td>One mark per correct row.
IGNORE 'yes', 'no' and ticks and crosses
DO NOT CREDIT if anything incorrect is written in any box in the molecule column.
e.g. 'starch or cellulose' = 0 mark

ACCEPT maltose
DO NOT CREDIT sucrose

ACCEPT casein / lactoglobulin / lactalbumin / polypeptide

IGNORE amylopectin</td></tr>
<tr><td>1</td><td>(a)</td><td>(ii)</td><td>milk is already, cloudy / an emulsion / white / AW ;</td><td>1</td><td>ACCEPT idea of difficulty in detecting change because of the appearance of milk</td></tr>
<tr><td>1</td><td>(a)</td><td>(iii)</td><td>(one) glycerol / glyceride ;
3 fatty acids ;

ester bond (between glycerol and fatty acid) ;</td><td>3</td><td>ACCEPT marking points from clearly labelled diagram but DO NOT CREDIT if contradicted in text.
IGNORE individual atoms on diagram and look for correct position of labels
MAX 2 if phosphate group included (as could be confused with phospholipid)

ACCEPT on diagram if 3 shown and at least one labelled
ACCEPT triglycerides are esters</td></tr>
</table>

Question			Expected Answer	Mark	Additional Guidance
1	(b)				**MARK THE FIRST RESPONSE ON EACH NUMBERED LINE**
		1	(thermal) insulation ;		*1* **ALLOW** 'warmth'
		2	energy, store / source / release ;		*2* **CREDIT** answers that refer to the idea of lipid as a respiratory substrate but **DO NOT CREDIT** 'for respiration' unqualified **IGNORE** 'fat contains energy' without further qualification **DO NOT CREDIT** refs to producing energy or to quick energy release **ACCEPT** 'provides energy'
		3	protection ;		
		4	membranes / phospholipid bilayer / control entry and exit into cells ;		*4* **CREDIT** ref to cholesterol in membranes
		5	(steroid) hormones / named steroid hormone ;		
		6	buoyancy ;		
		7	waterproofing ;		
		8	source of water (from respiration) ;		
		9	(electrical insulation) in myelin / around neurones / around axons / around dendrons ;		*9* **CREDIT** nerve fibres / saltatory conduction **IGNORE** nerves
		10	aid, absorption / storage / production, of, fat soluble / A / D / E / K, vitamins ;	3	
1	(c)	(i)	saturated ; (fatty acids have) no / fewer, double bonds ; solid at room temperature ;	1 max	Assume answers refer to animal fats unless otherwise stated **ACCEPT** reverse argument **IGNORE** ref to fats and oils (as stated in question) **ACCEPT** 'fatty acids are not kinked' **ACCEPT** reasonable temperature quoted

Question			Expected Answer	Mark	Additional Guidance
1	(c)	(ii)			
		1	(death rate for) men greater (at any concentration) / AW ;		*1* **ACCEPT** ora
		2	(death rates) rise with increasing cholesterol / AW ;		*2* **ACCEPT** 'positive correlation' (between death and cholesterol)
		3	death rate for men, initially / AW, falls ;		*3* **ACCEPT** 4.8 or below as 'initially'.
		4	steep(er) / AW, rise (in, males / both) at higher cholesterol levels ;		*4* Answers must refer to latter part of graph only (5.7 or above). **ACCEPT** difference (between sexes) greater at high concentration
		5	comparative figures with unit for (blood) cholesterol to support any of the above points ;		*5* There are 3 ways of getting this mark: • values for both sexes at single concentration • two values for single sex at two concentrations • subtraction / calculation, that shows comparison **IGNORE** terms like 'about' See table for acceptable examples of x and y values – if intermediate cholesterol values are used, refer to the graph for the data
				3 max	

blood cholesterol (mmol dm^{-3})	deaths per 10 000	
	women	men
3.6	13.2 - 14.1	31.2 - 32.1
4.3	15.0 - 15.9	26.0 - 26.9
4.8	14.0 - 14.9	24.0 - 24.9
5.2	15.1 - 16.0	24.6 - 25.5
5.7	17.4 - 18.3	25.8 - 26.7
6.2	17.8 - 18.7	33.2 - 34.1
6.7	23.5 - 24.3	31.3 - 32.2
7.3	22.0 - 22.9	44.1 - 45.0
8.2	31.7 - 32.6	59.5 - 60.4

Must include (blood) cholesterol units **Any figure within a particular range is acceptable**

Question			Expected Answer	Mark	Additional Guidance
1	(c)	(iii)			**Mark first two in list**
		1	coronary heart disease / CHD / cardio-vascular diseases / heart attack / cardiac arrest / myocardial infarction / MI / angina **;**		***1*** **DO NOT CREDIT** heart disease alone or 'conary' **ACCEPT** hypertension / high blood pressure
		2	atherosclerosis / atheroma **;**		***2*** **DO NOT CREDIT** arteriosclerosis
		3	stroke **;**		
		4	Type 2 diabetes **;**		
				2	
			Total	**16**	