Lipids (fats)

2

✓ **Main Function:** long-term energy storage

✓ **Other Functions:** thermal insulation, absorb fat-soluble vitamins (A,D,E,K), form cell membranes, steroids

✓ **Special Feature:** contain more energy per gram than any other biological molecule (9 cal/g)

✓ **Groupings**: Mostly C and H atoms (hydrocarbons)

✓ **Types**: 1. Triglycerides 2. Phospholipids 3. Steroids

Lipids

Which are made of

↓

Glycerol & 3 Fatty Acids

which contain

↓

Carbon, hydrogen, oxygen

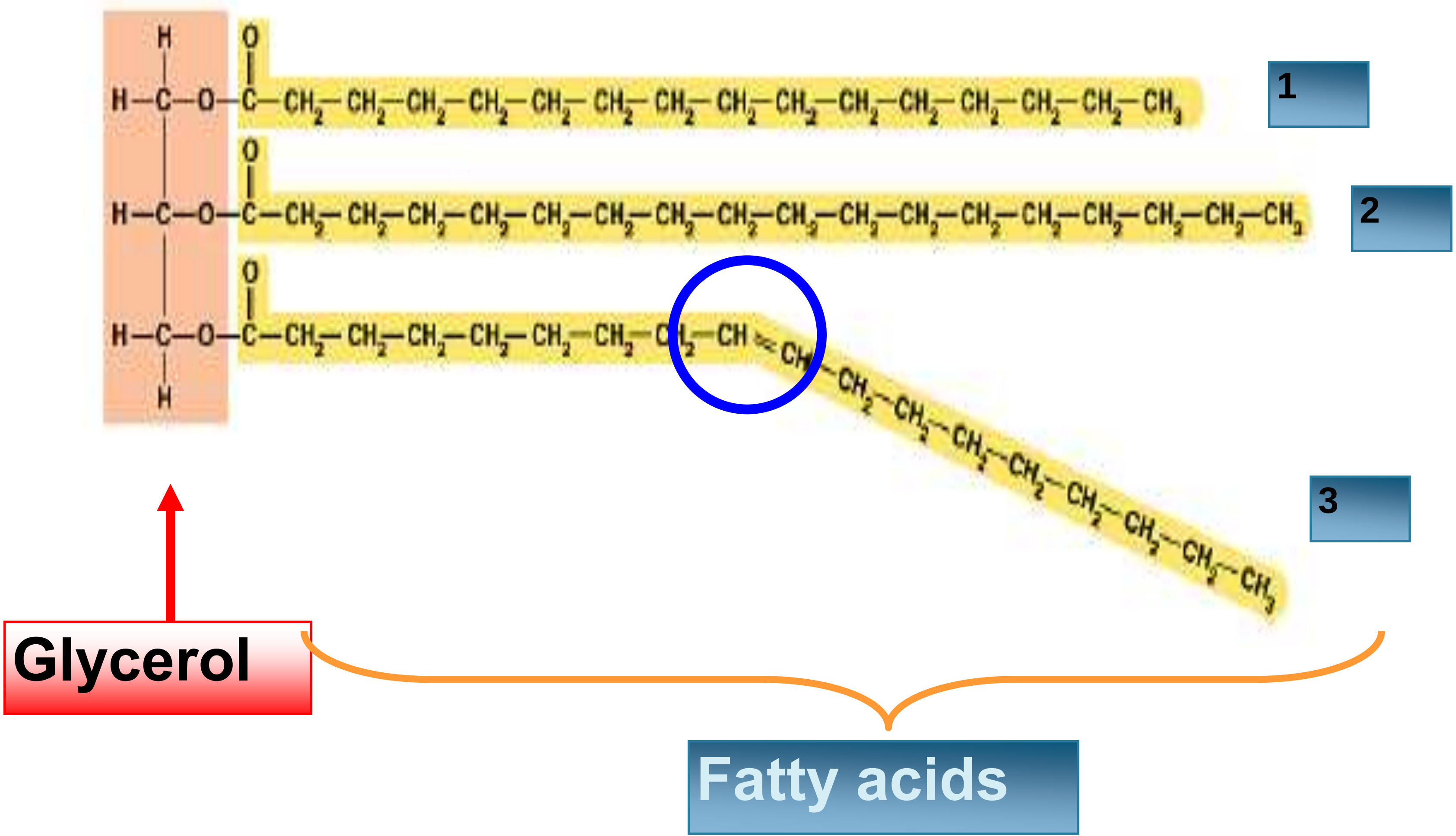
↓ main function

ENERGY STORAGE

long-term

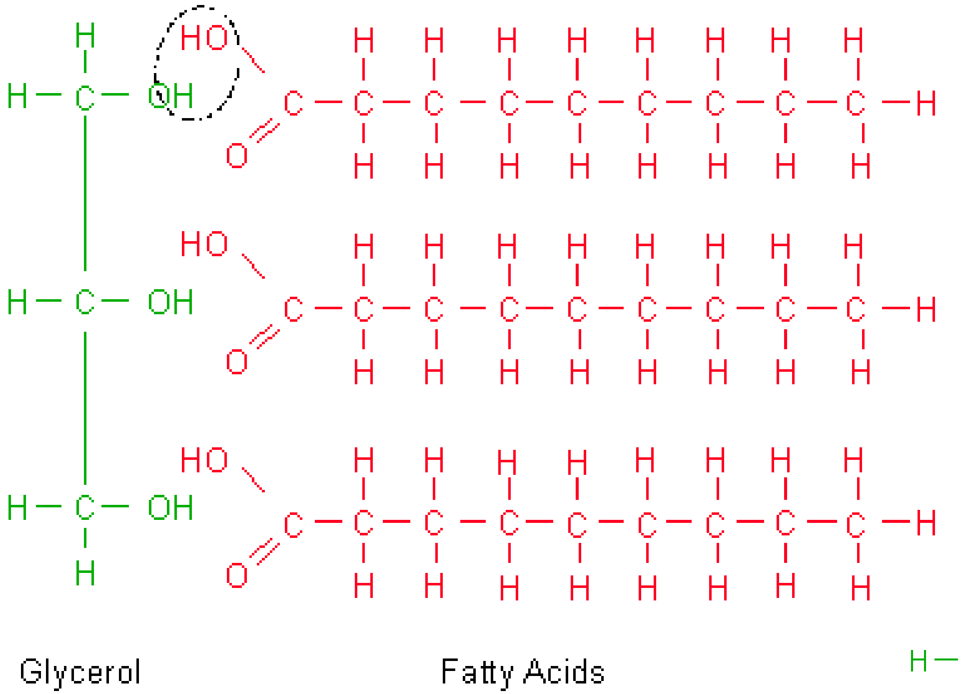
Plant oils (liquid @ room

Triglycerides

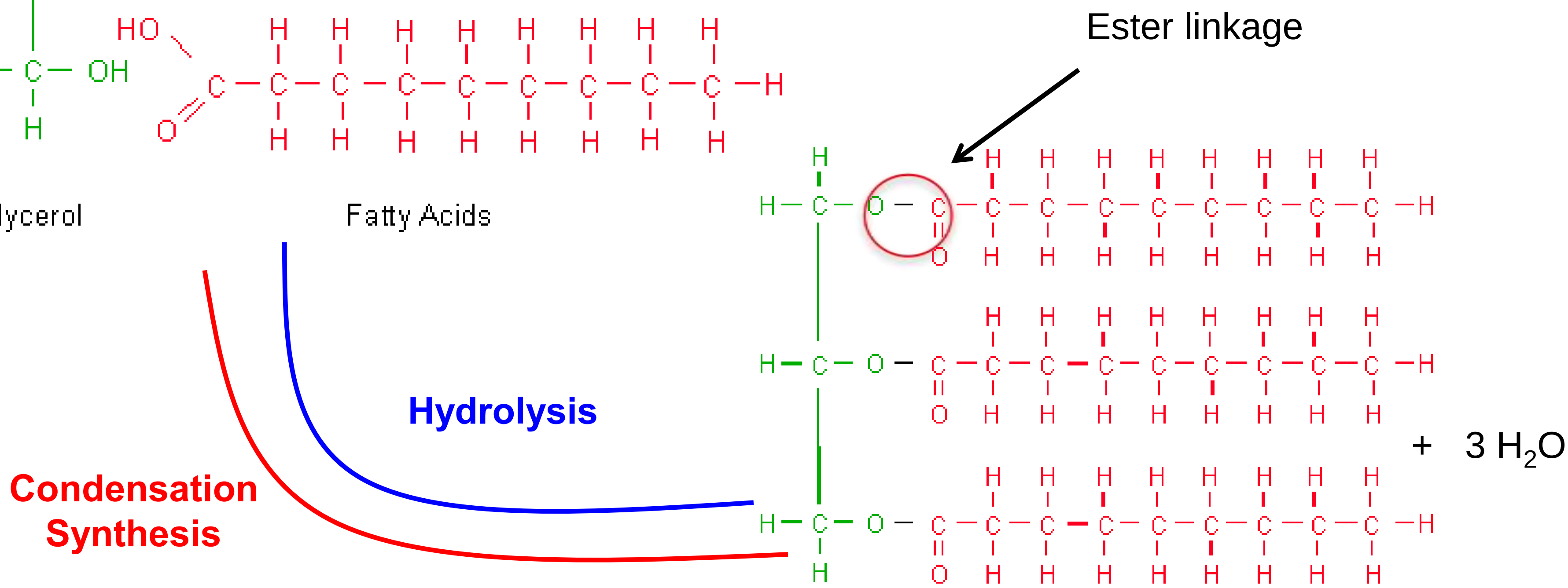


Making and Breaking Lipids (fats)

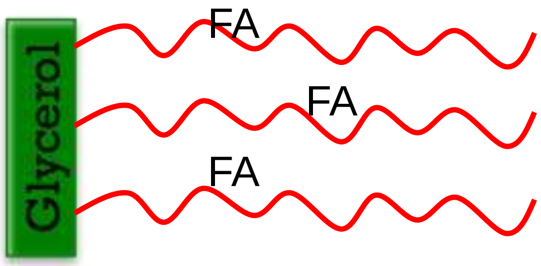
Fats and oils are called triglycerides because of their structure



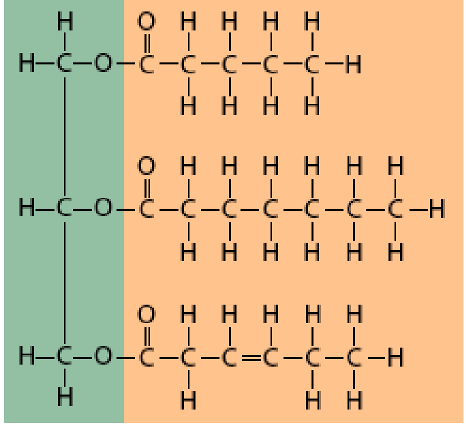
What functional groups are present on the glycerol and fatty acid molecules?



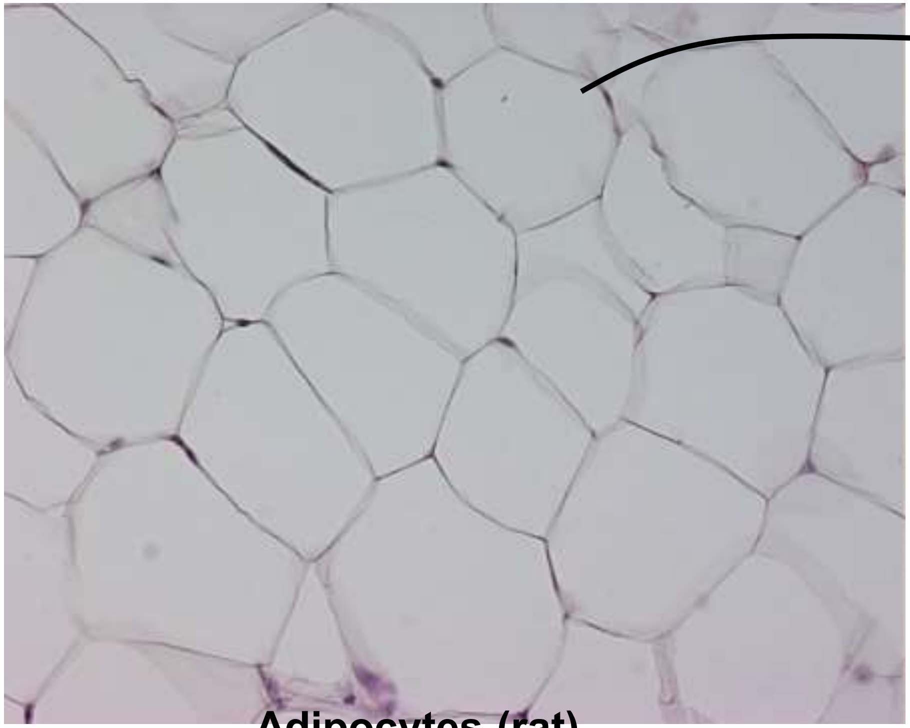
Triglycerides



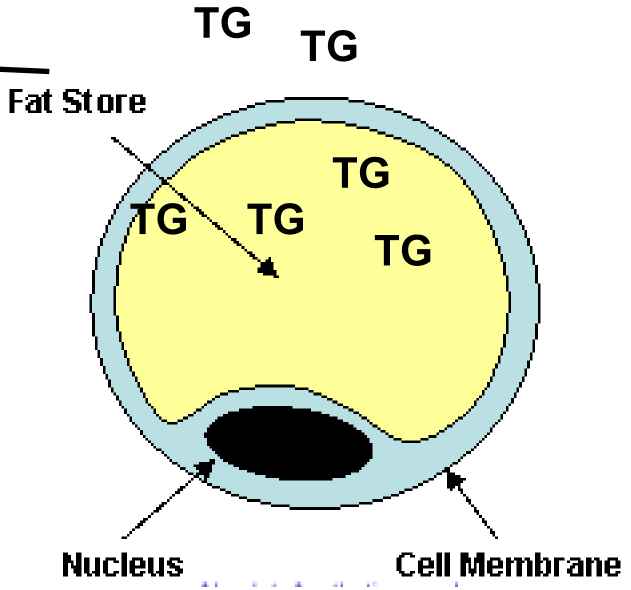
= **TG** (Triglyceride)



Lipid droplet



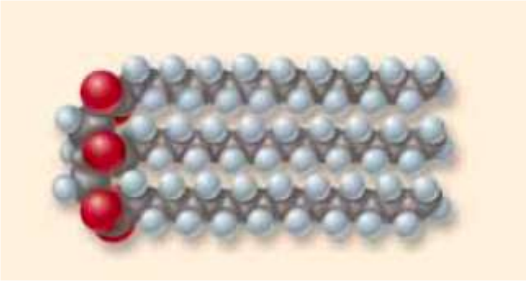
Adipocytes (rat)

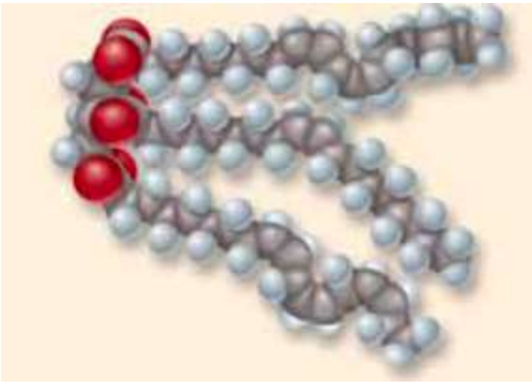


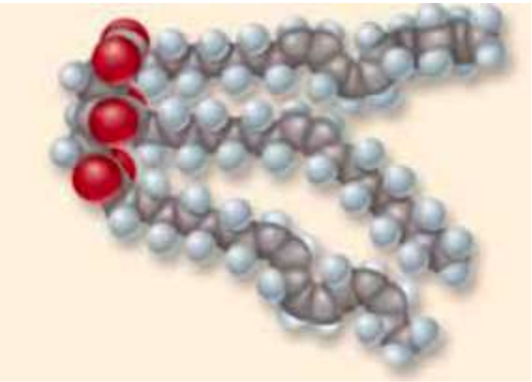
Courtesy of Dr. Ceddia – York University

Types of Fatty Acids

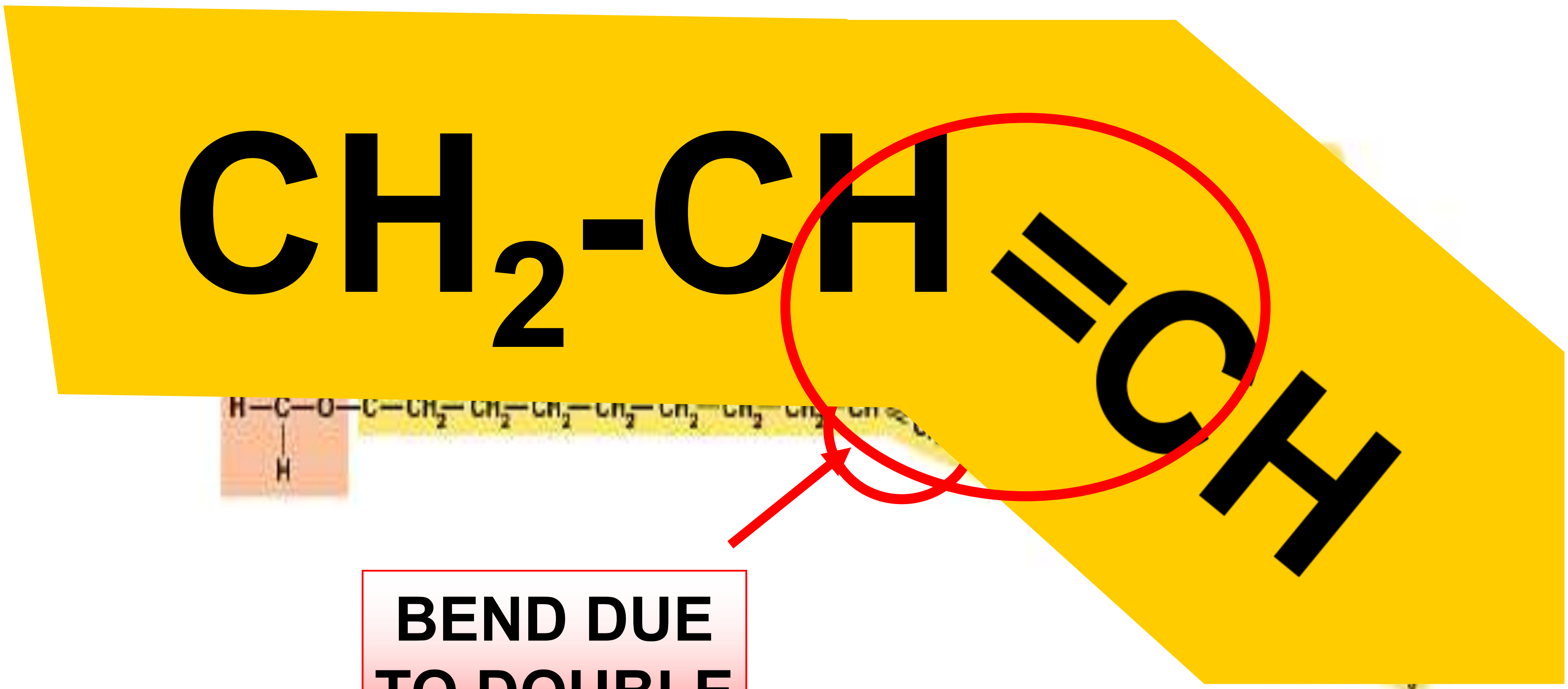
Saturated	Unsaturated	Polyunsaturated
No double bonds	Has at least one double bond	Several double bonds







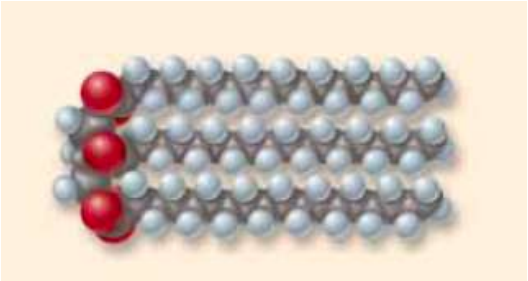
Types of Fatty Acids

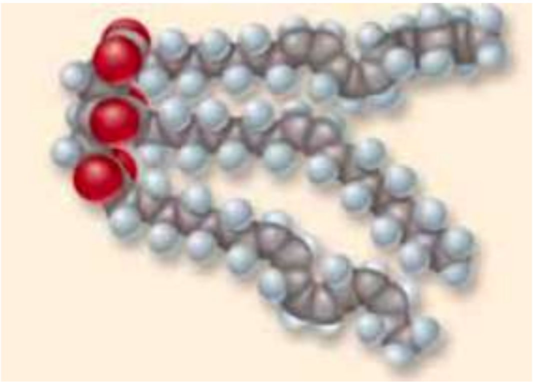


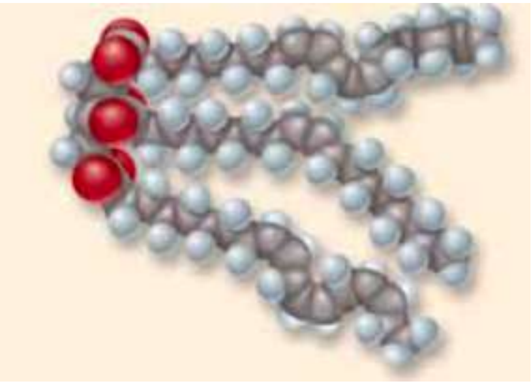
BEND DUE TO DOUBLE BOND

Types of Fatty Acids

Saturated	Unsaturated	Polyunsaturated
Straight chains	Kinks / bends at the double bonds	Kinks / bends at the double bonds

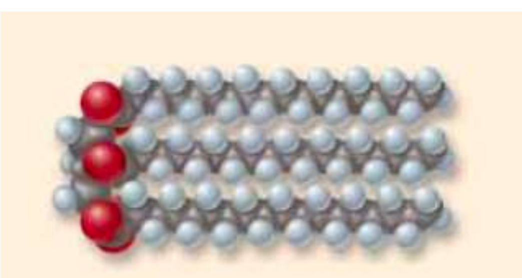


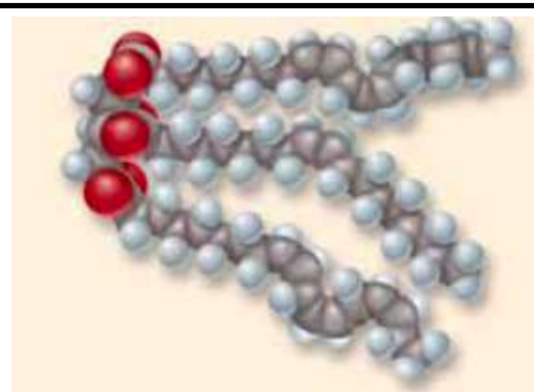


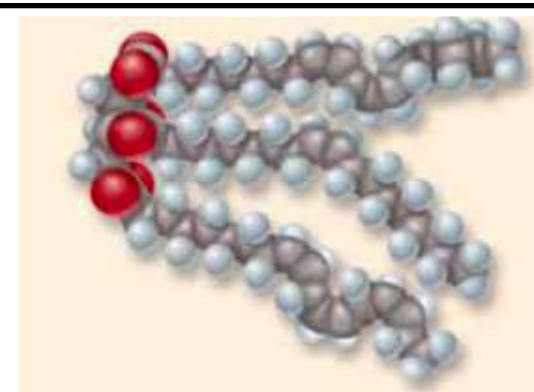


Which is better for you?

Saturated	Unsaturated Polyunsaturated
butter, lard	olive oil, vegetable oil, peanut oil, canola oil

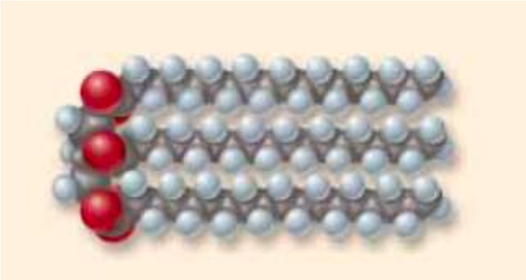


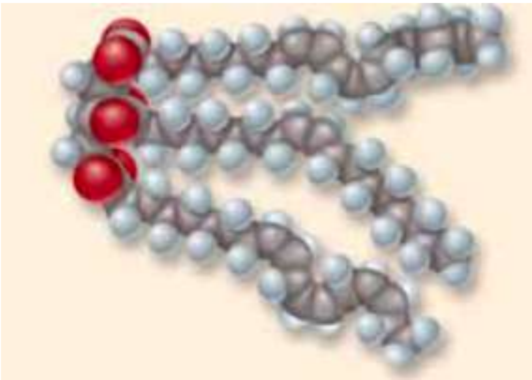


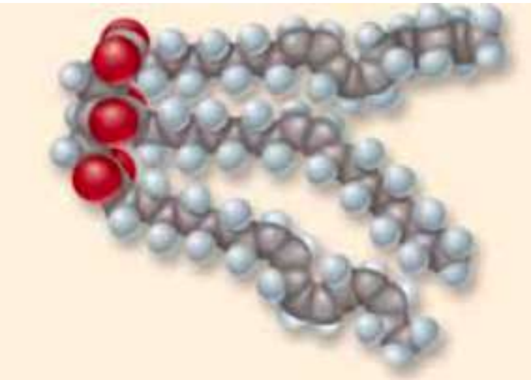


Which is better for you?

Saturated	Unsaturated	Polyunsaturated
Fatty acids pack closely, solid @ RT	Fatty acids are not packed closely, liquid @ RT	



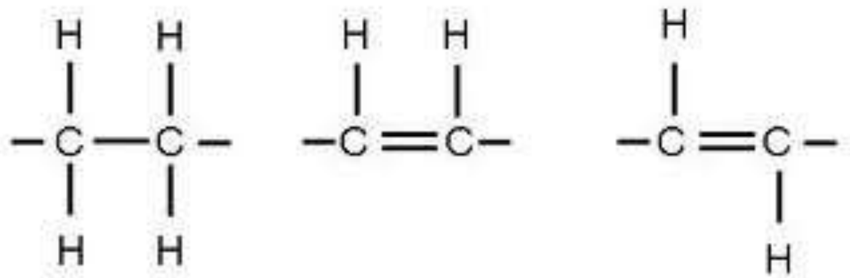




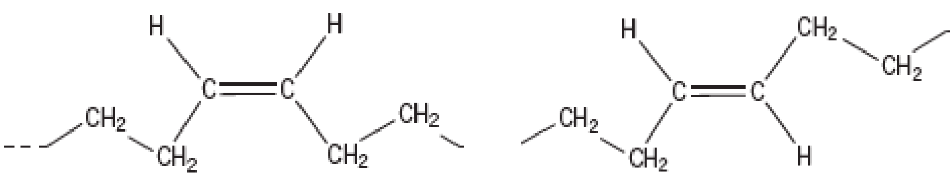
Types of Fatty Acids

Taking a perfectly good fat and making it bad!

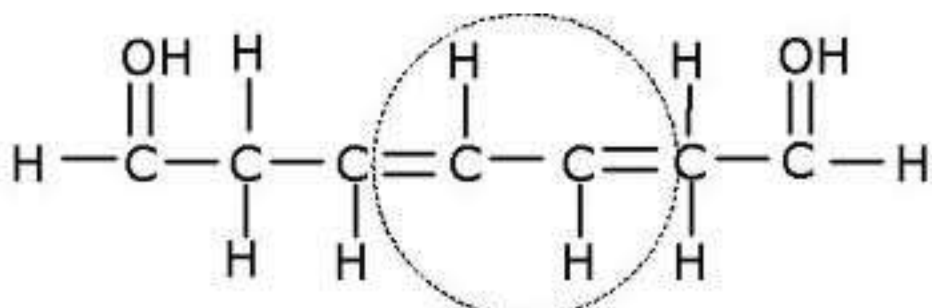
Addition of hydrogen atoms to the acid, causing double bonds to become single ones.
(unsaturated becomes saturated)



Saturated Fat — Unsaturated Fat — Trans fat

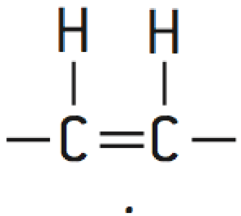
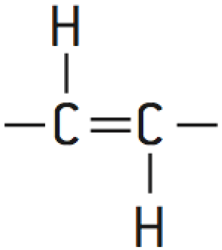


cis arrangement about a double bond — *trans* arrangement about a double bond



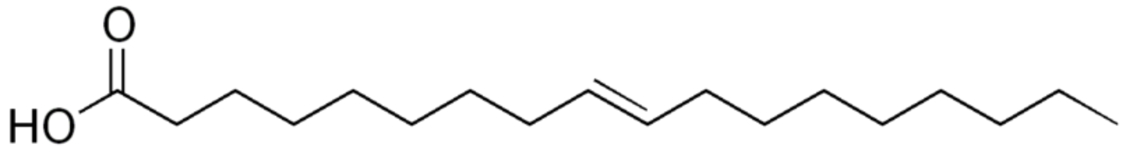
"Trans" fatty acid

2.3.U3 Unsaturated fatty acids can be cis or trans isomers.

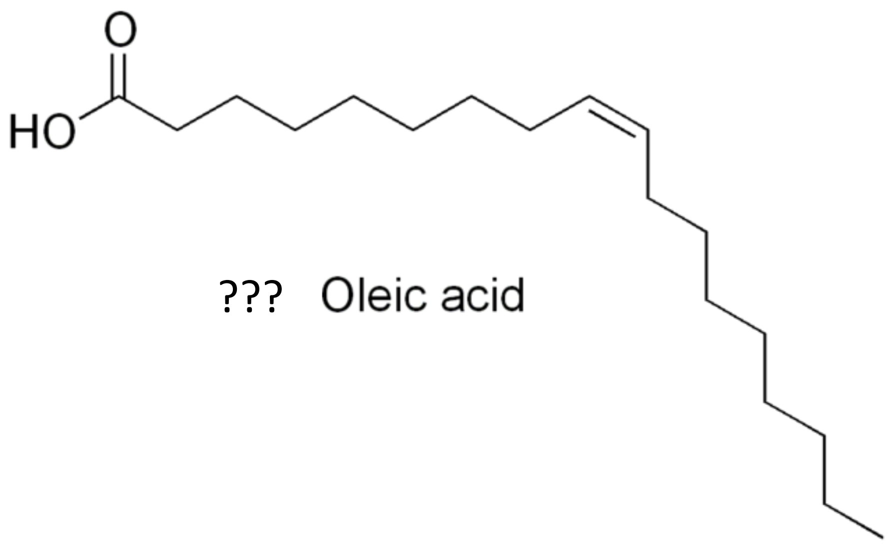
Cis-isomers	Trans-isomers
	
Very common in nature	Rare in nature – usually artificially produced to produce solid fats, e.g. margarine from vegetable oils.
the hydrogen atoms are on the same side of the two carbon atoms	the hydrogen atoms are on the same side of the two carbon atoms
The double bond causes a bend in the fatty acid chain	The double bond does not causes a bend in the fatty acid chain
Therefore cis-isomers are only loosely packed	Trans-isomers can be closely packed
Triglycerides formed from cis-isomers have low melting points – they usually liquid at room temperature	Triglycerides formed from trans-isomers have high melting points – they usually solid at room temperature

2.3.U3 Unsaturated fatty acids can be cis or trans isomers.

Q1 trans or cis isomers?



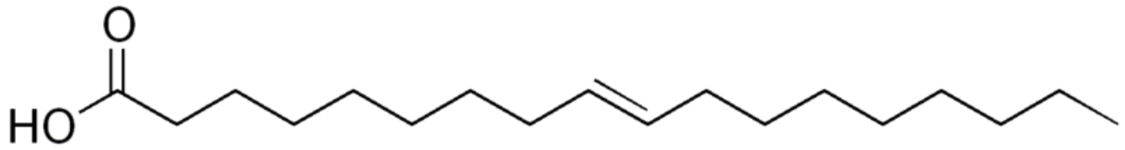
??? Oleic acid



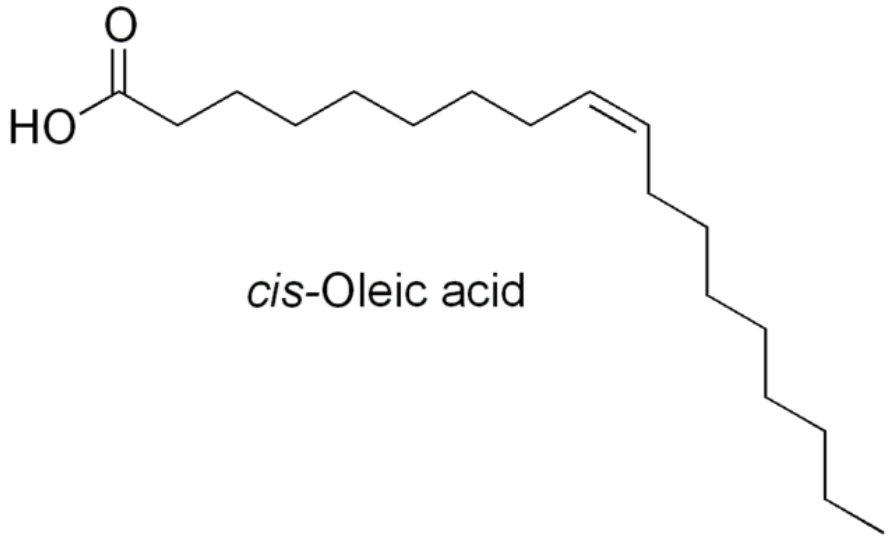
??? Oleic acid

2.3.U3 Unsaturated fatty acids can be cis or trans isomers.

Q1 trans or cis isomers?



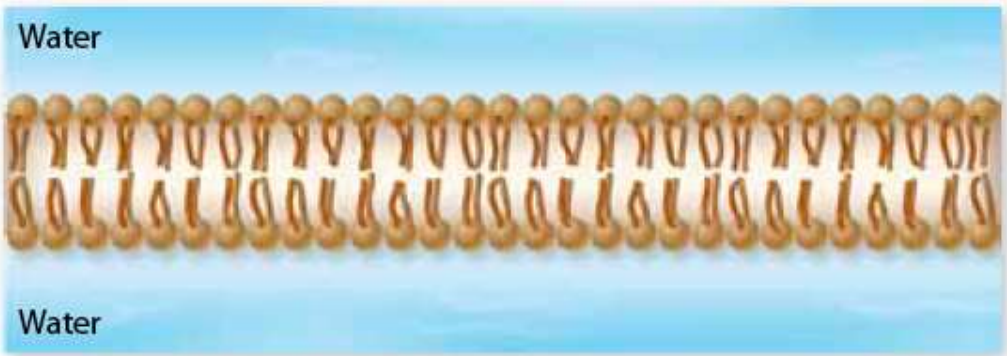
trans-Oleic acid



cis-Oleic acid

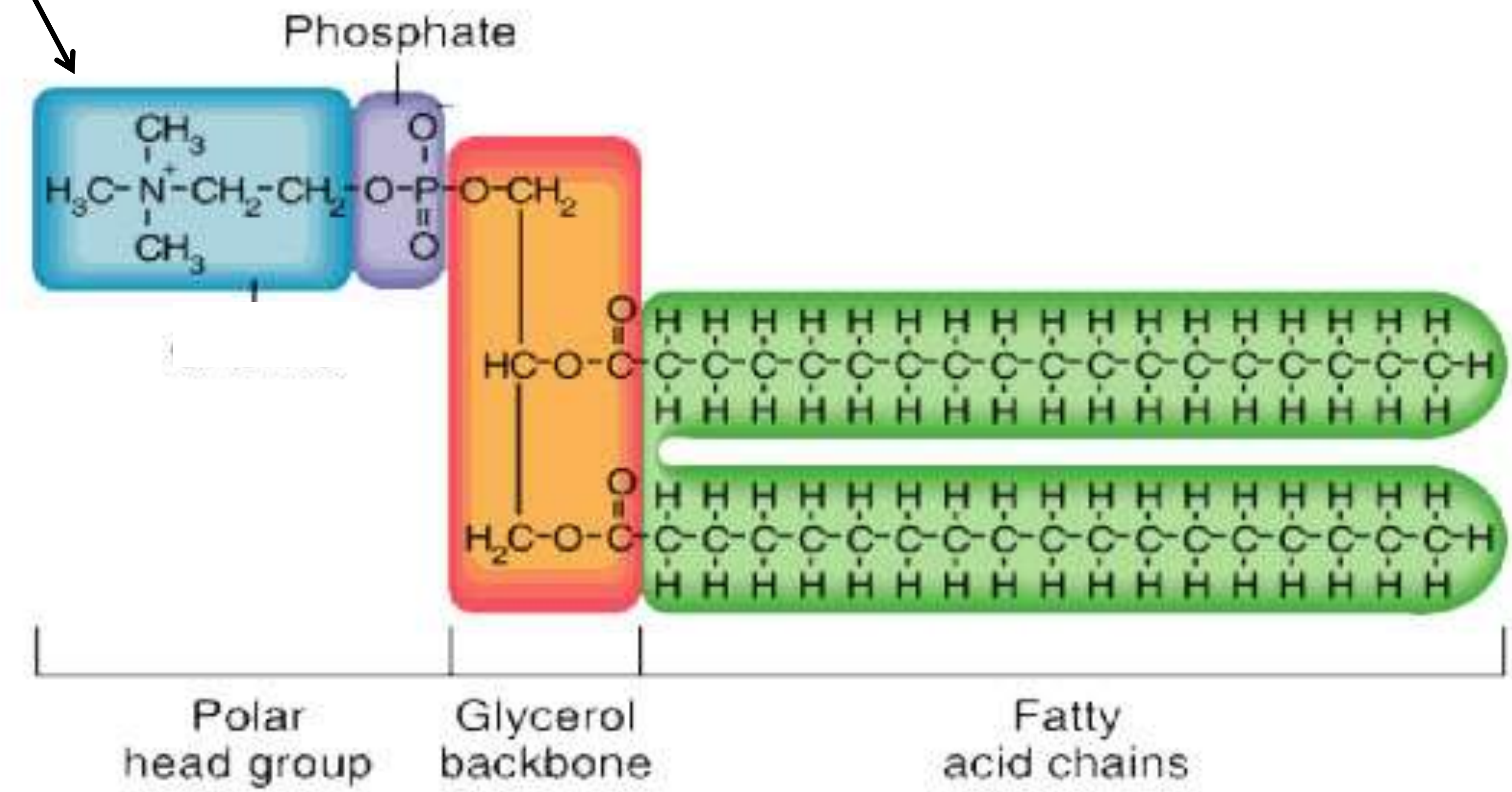
Phospholipids

- Phospholipids (along with glycolipids, cholesterol and proteins) make up an important part of the cell membrane
- Fat derivatives in which one fatty acid has been replaced by a phosphate group and one of several nitrogen-containing molecules.



Phospholipids

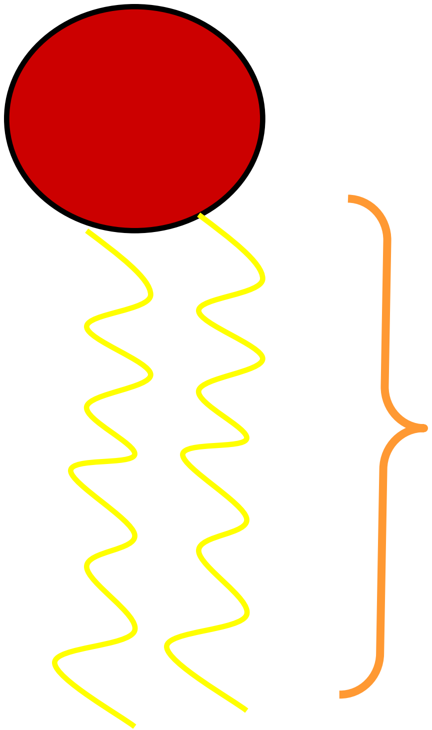
Nitrogen-containing group



e.g. R group called choline and is called Phosphatidylcholine

Phospholipids

The phospholipid can also be represented as:

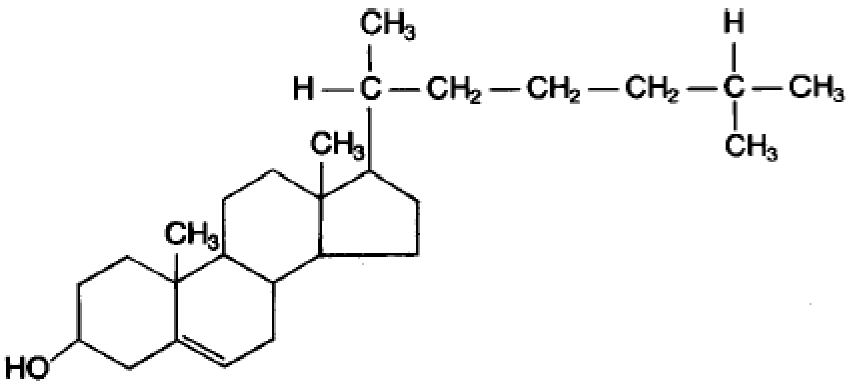


Polar Head – hydrophilic (water-loving)

Non-Polar Tails (fatty acids) – hydrophobic (water-hating)

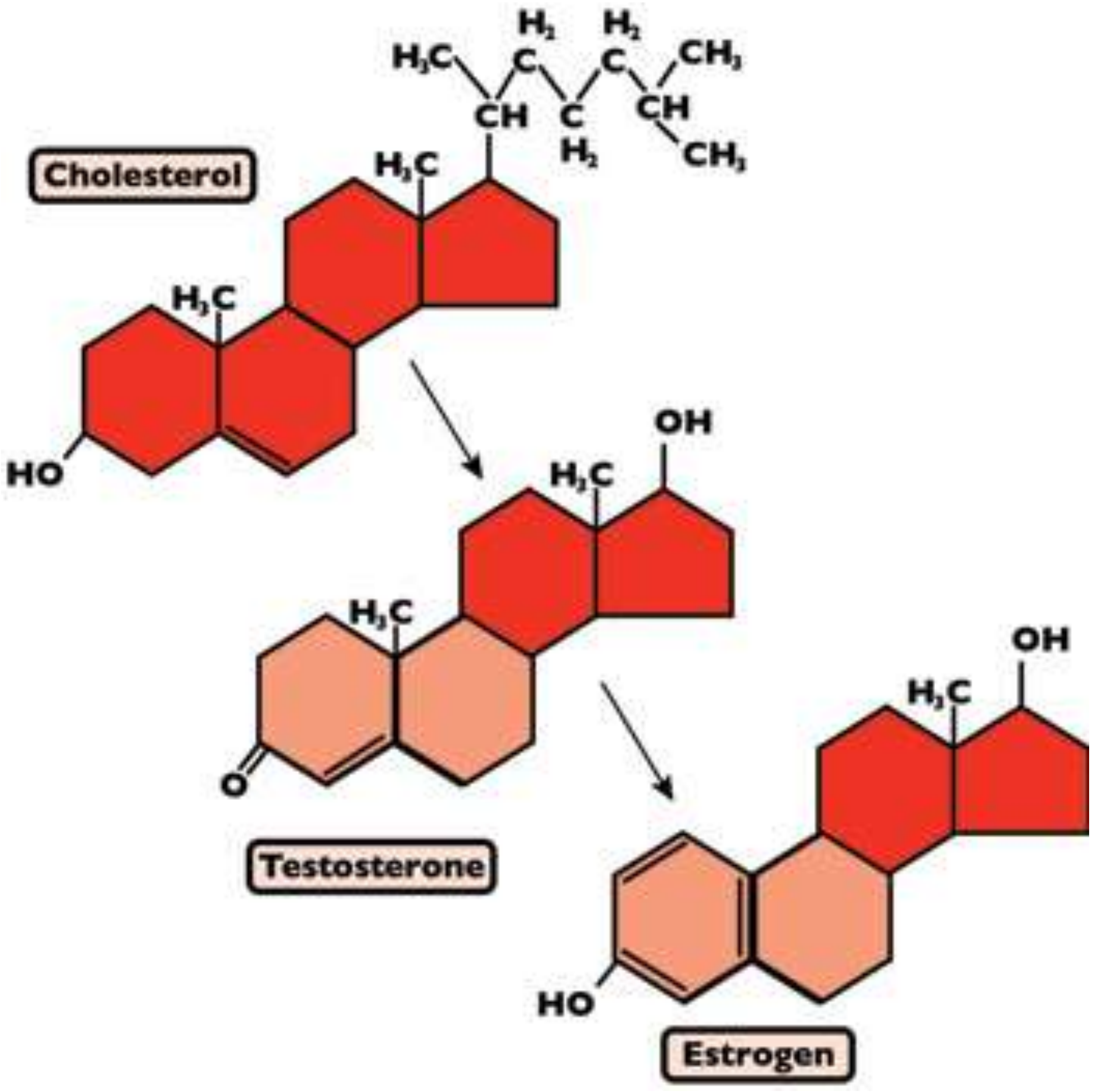
Steroids

Steroids consist of 4 fused carbon rings with an alcohol group



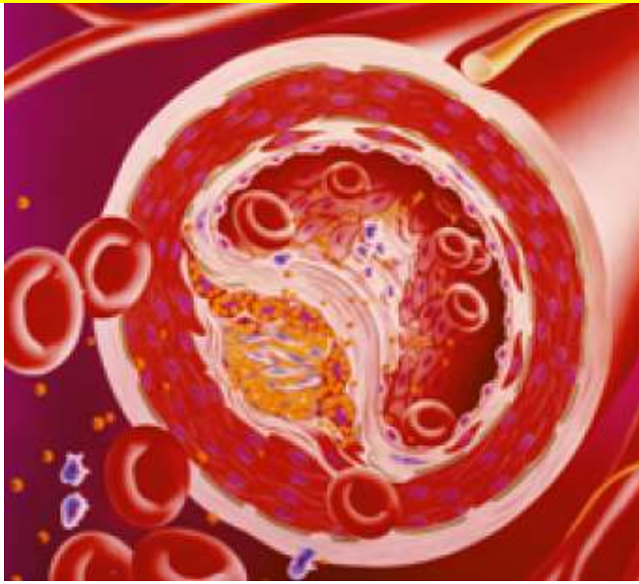
Cholesterol

- Precursor for other steroids
- Reacts with sunlight to form Vitamin D
- Component of animal cell membranes
- Contributes to atherosclerosis
- Produced in the liver



Precursor for other hormones

Cholesterol



Since cholesterol is not soluble in the blood, it must be transported by lipoproteins

Two lipoproteins are **HDL & LDL**

HDL molecules are smaller and denser, with a high amount of protein

LDL molecules contain much more cholesterol and can cause serious health effects

HDL is “good”; LDL is “bad”

2.3.A4 Evaluation of evidence and the methods used to obtain the evidence for health claims made about lipids.

Evidence for health claims comes from research. Some of this research is more scientifically valid than others.

Evaluation = Make an appraisal by weighing up the **strengths** and **limitations**

Key questions to consider for the **strengths** are:

- Is there a (negative or positive) correlation between intake of the lipid being investigated and rate of the disease or the health benefit?
- If instead mean values are being compared how different are they? Has this difference been assessed statistically?
- How widely spread is the data? This can be assessed by the spread of data points or the relative size of error bars. The more widely spread the data the smaller the significance can be placed on the correlation and/or the conclusion.

n.b. it is easiest to consider strengths by looking at effectively drawn graphs.

Key questions to consider for the **limitations** are:

- Was the measure of the health a valid one? e.g. cholesterol levels in blood are more informative than body mass index
- How large was the sample size? Larger samples are more reliable.
- Does the sample reflect the population as a whole or just a particular sex, age, state of health, lifestyle or ethnic background?
- Was the data gathered from human or animal trials? If only done of animals how applicable are the findings?
- Were all the important control variables, e.g. level of activity, effectively controlled?
- Were the levels and frequency of the lipids (or substance studied) intake realistic?
- How rigorous were the methods used to gather data? e.g. If only a survey was used how truthful were the respondents?

2.3.A2 Scientific evidence for health risks of trans fats and saturated fatty acids.

There have been many claims about the effects of different types of fat on human health. The main concern is coronary heart disease (CHD). In this disease the coronary arteries become partially blocked by fatty deposits, leading to blood clot formation and heart attacks.

- A positive correlation has been found between saturated fatty acid intake and rates of CHD in many studies.
- Correlation ≠ causation. Another factor, e.g. dietary fibre could be responsible.
- There are populations that do not fit the correlation such as the Maasai of Kenya. They have a diet that is rich in meat, fat, blood and milk. They therefore have a high consumption of saturated fats, yet CHD is almost unknown among the Maasai.
- Diets rich in olive oil, which contains cis-monounsaturated fatty acids, are traditionally eaten in countries around the Mediterranean. The populations of these countries typically have low rates of CHD and it has been claimed that this is due to the intake of cis-monounsaturated fatty acids.
- Genetic factors in these populations could be responsible.
- Other aspects of the diet could explain the CHD rates.
- There is also a positive correlation between amounts of trans-fat consumed and rates of CHD.
- Other risk factors have been tested, to see if they can account for the correlation, but none did. Trans-fats therefore probably do cause CHD.
- In patients who had died from CHD, fatty deposits in the diseased arteries have been found to contain high concentrations of trans-fats, which gives more evidence of a causal link.

http://oliveoilsindia.com/green-olives/green-olives.jpg

2.3.S2 Determination of body mass index by calculation or use of a nomogram.

In some parts of the world food supplies are insufficient or are unevenly distributed and many people as a result are **underweight**.

In other parts of the world a likelier cause of being underweight is anorexia nervosa. This is a psychological condition that involves voluntary starvation and loss of body mass.

Obesity is an increasing problem in some countries. Obesity increases the risk of conditions such as coronary heart disease and type II diabetes. It reduces life expectancy significantly and is increasing the overall costs of health care in countries where rates of obesity are rising.

Body Mass Index (BMI) is used as a screening tool to identify possible weight problems, however, BMI is not a diagnostic tool. To determine if excess weight is a health risk further assessments are needed such as:

- skinfold thickness measurements
- evaluations of diet
- physical activity
- and family history

The table below can be used to assess an adult's status

BMI	Status
Below 18.5	Underweight
18.5 – 24.9	Normal
25.0 – 29.9	Overweight
30.0 and Above	Obese

2.3.S2 Determination of body mass index by calculation or use of a nomogram.

BMI is calculated the same way for both adults and children. The calculation is based on the following formula:

$$\text{BMI} = \frac{\text{mass in kilograms}}{(\text{height in metres})^2}$$

n.b. units for BMI are kg m^{-2}

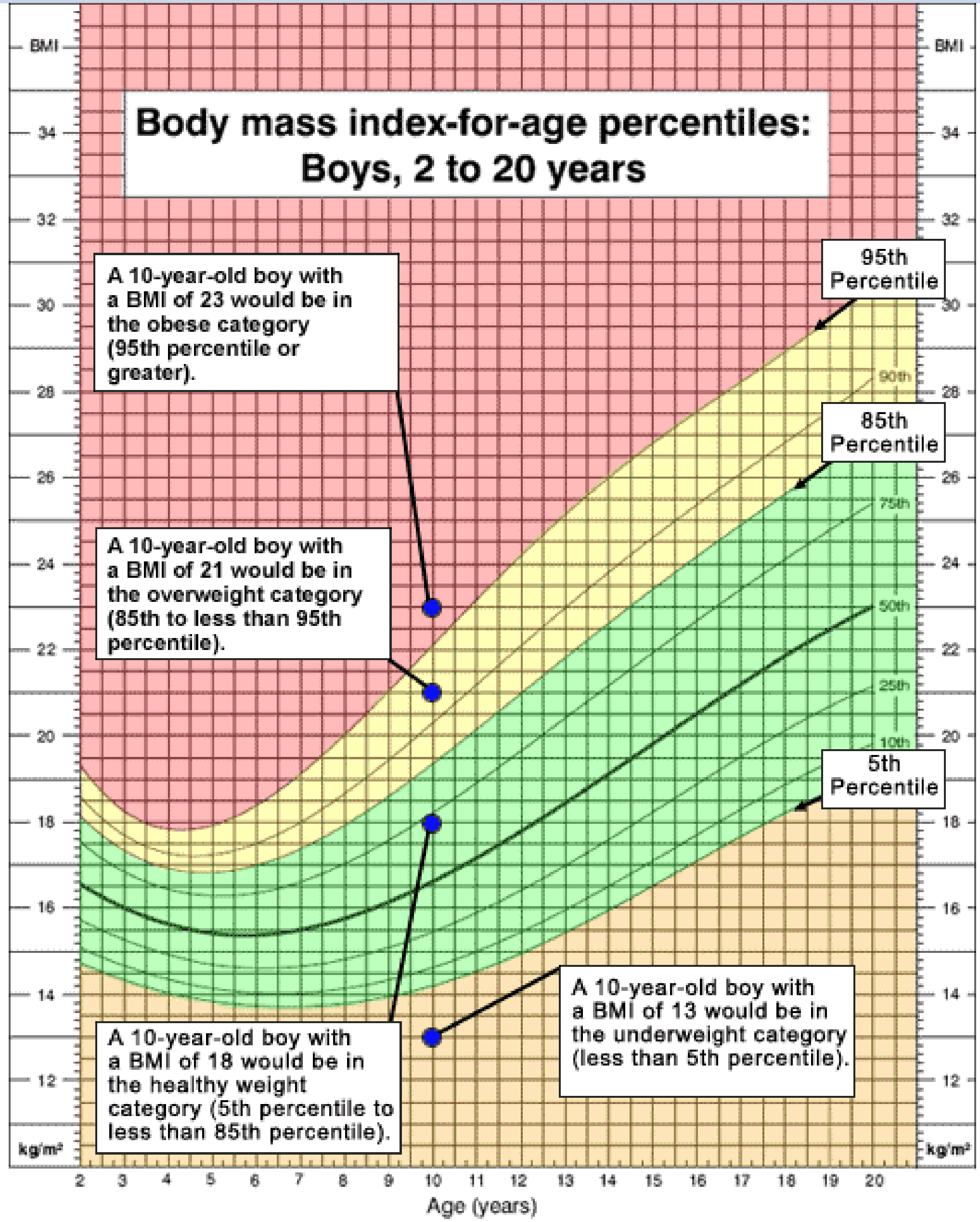
Example:

Mass = 68 kg, Height = 165 cm (1.65 m)

BMI = 68 ÷ $(1.65)^2$ = 24.98 kg m^{-2}

In this example the adult would be (borderline) overweight - see the table on the previous slide

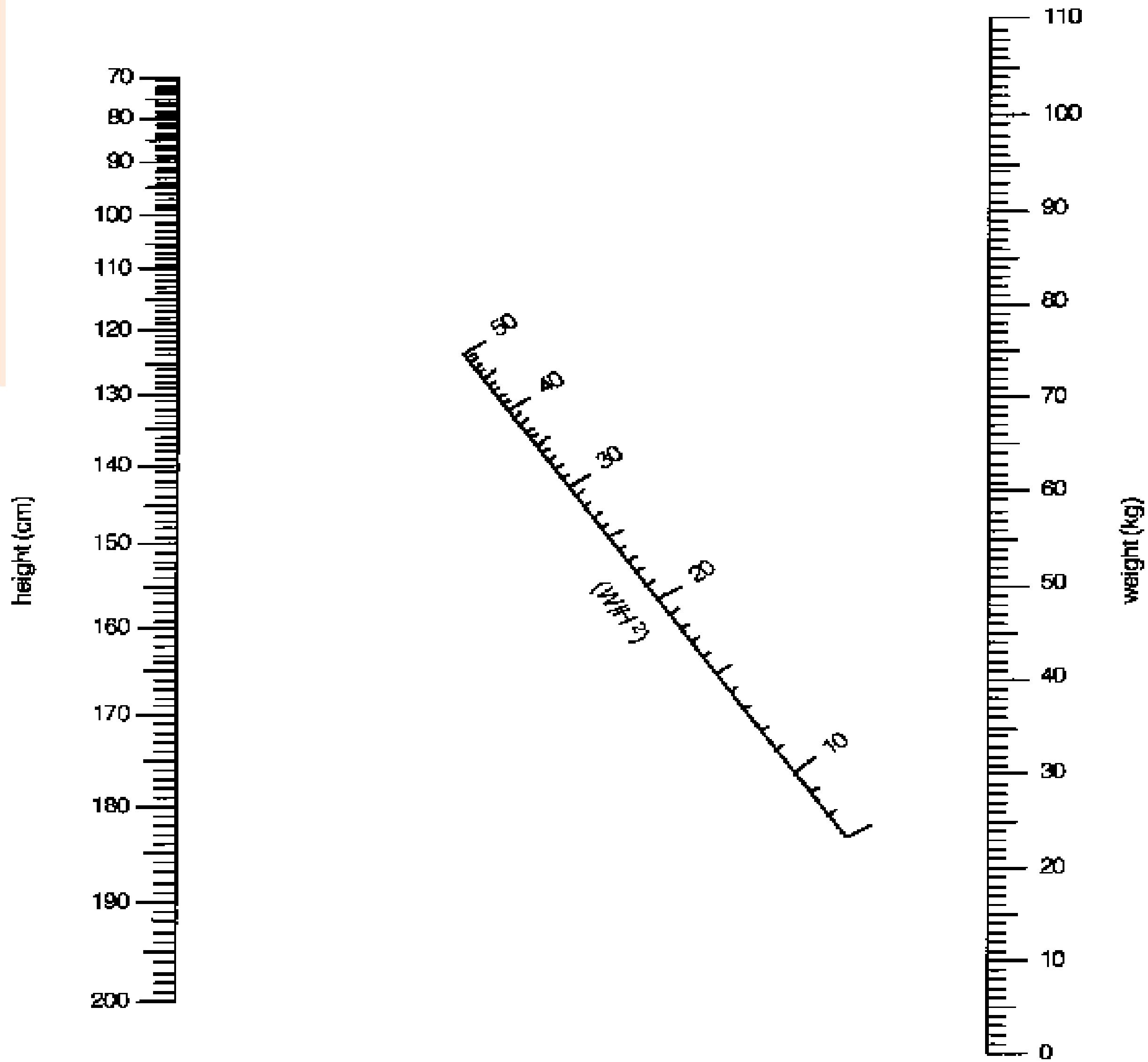
Charts such as the one to the right can also be used to assess BMI.



2.3.S2 Determination of body mass index by calculation or use of a nomogram.

An alternative to calculating the BMI is a nomogram. Simply use a ruler to draw a line from the body mass (weight) to the height of a person. Where it intersects the W/H^2 line the person's BMI can be determined. Now use the table to assess their BMI status.

BMI	Status
Below 18.5	Underweight
18.5 – 24.9	Normal
25.0 – 29.9	Overweight
30.0 and Above	Obese



http://helid.digicollection.org/documents/h0211e/p434.gif

2.3.S2 Determination of body mass index by calculation or use of a nomogram.

1. A man has a mass of 75 kg and a height of 1.45 metres.
   a. Calculate his body mass index. (1)

   b. Deduce the body mass status of this man using the table. (1)

   c. Outline the relationship between height and BMI for a fixed body mass. (1)

2.3.S2 Determination of body mass index by calculation or use of a nomogram.

1. A man has a mass of 75 kg and a height of 1.45 metres.
   a. Calculate his body mass index. (1)

BMI = mass in kilograms ÷ (height in metres)^2

= 75 kg ÷ (1.45 m)^2
= 75 kg ÷ 2.10 m^2
= 35.7 kg m^{-2}

   b. Deduce the body mass status of this man using the table. (1)

35.7 kg m^{-2} is above 30.0 (see table below) therefore the person would be classified obese.

BMI	Status
Below 18.5	Underweight
18.5 – 24.9	Normal
25.0 – 29.9	Overweight
30.0 and Above	Obese

   c. Outline the relationship between height and BMI for a fixed body mass. (1)

The taller a person the smaller the BMI;

(negative correlation, but not a linear relationship)

2.3.S2 Determination of body mass index by calculation or use of a nomogram.

2. A woman has a height of 150 cm and a BMI of 40.
   a. Calculate the minimum amount of body mass she must lose to reach normal body mass status. Show all of your working. (3)

   b. Suggest two ways in which the woman could reduce her body mass. (2)

2.3.S2 Determination of body mass index by calculation or use of a nomogram.

4. A woman has a height of 150 cm and a BMI of 40.
   a. Calculate the minimum amount of body mass she must lose to reach normal body mass status. Show all of your working. (3)
   b. Suggest two ways in which the woman could reduce her body mass. (2)

Reduce her nutritional intake / diet / reduce the intake of lipids;
Exercise / increase activity levels;

BMI = mass in kilograms ÷ (height in metres)^2

therefore

mass in kilograms = BMI ÷ (height in metres)^2

Actual body mass = BMI ÷ (height in metres)^2
= 40 kg m^{-2} x (1.50 m)^2
= 90 kg

Normal BMI is a maximum of 24.9 kg m^{-2}

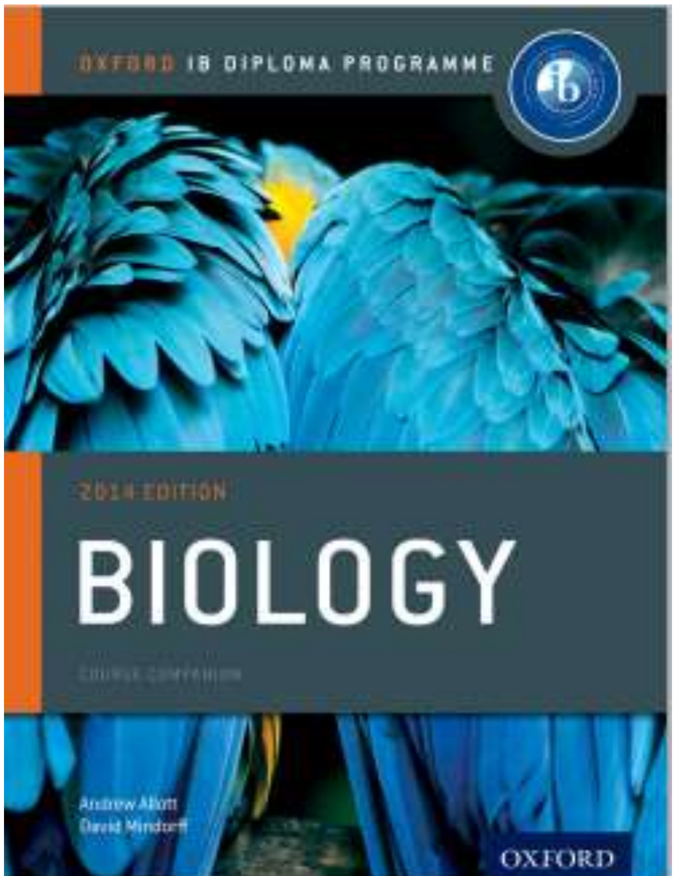
Normal body mass = 24.9 kg m^{-2} x (1.5 m)^2
= 56 kg

To reach normal status the woman needs to lose
90 kg – 56 kg = 34 kg

Bibliography / Acknowledgments

BioNinja

Your one-stop biology resource



Jason de Nys