The Chemistry of Food

Name: ANSWERS

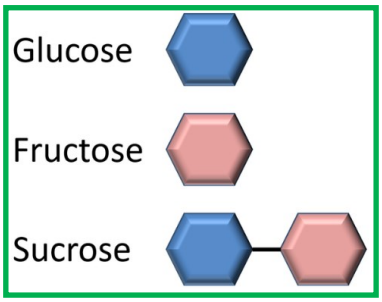
The Chemistry of Food

Carbohydrates, lipids and proteins are the main compounds that make up the structure of a cell. They are vital components of a balanced diet of any organism that can not makes its own food.

Carbohydrates, lipids and proteins are the large molecules that are often made up by smaller molecules joined together as part of the cell metabolism.

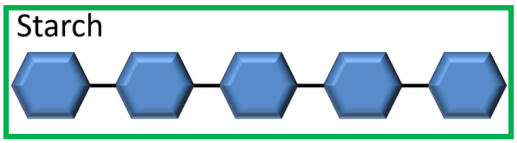
Carbohydrates:

Carbohydrates provide us with the fuel that makes all of the other reactions of life possible. They contain the chemical elements carbon, hydrogen and oxygen.



All carbohydrates are made up of units of sugars.

⇒ Some carbohydrates contain only 1 sugar unit. The best known of these sugars is glucose $C_6H_{12}O_6$. Other carbohydrates are made up of 2 sugar units joined together , for example sucrose, the compound we call sugar in everyday life. These small carbohydrate sugars are known as simple sugars.

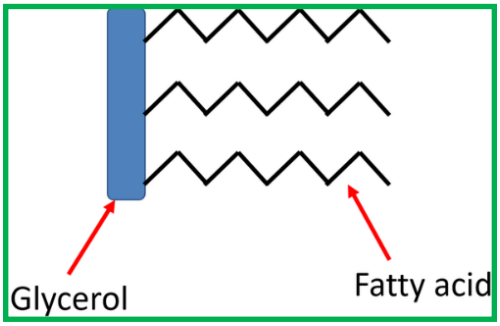


⇒ Complex carbohydrates such as starch and cellulose are made up of long chains of simple sugars bonded together.

Carbohydrate rich foods include bread, potatoes, rice and pasta. Most of the carbohydrates we eat will be broken down into glucose, used in cellular respiration to provide energy for metabolic reactions in your cells. The carbohydrate cellulose is an important support material in plants.

Lipids:

Lipids are fats (solids) and oils (liquids). They are the most efficient energy store in your body and an important source of energy in your diet. Combined with other molecules, lipids are very important in your cell membranes, as hormones, and in your nervous system. Like carbohydrates, lipids are made up of carbon, hydrogen and oxygen. All lipids are insoluble in water.



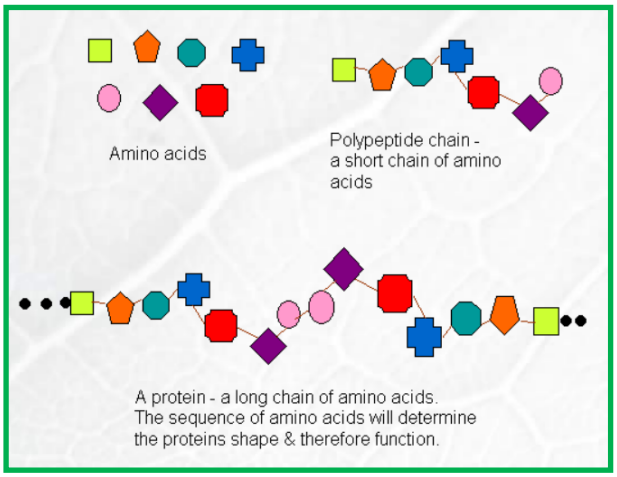
Lipids are made of 3 molecules of fatty acids joined to a molecule of glycerol. The glycerol is always the same, but the fatty acids vary. Lipid-rich foods includes all the oils, such as olive oil, as well as butter, margarine, cheese and cream. The different combination of fatty acids affects whether the lipid will be a liquid or an oil.

Proteins:

Proteins are used for building up the cells and tissues in your body, as well as the basis of all your enzymes. Between 15 and 16% of your body mass is protein. Protein is found in tissues ranging from your hair and nails to muscles and the enzymes that control your body chemistry. Proteins are made up of the elements carbon, hydrogen, oxygen and nitrogen. Protein rich foods include meat, fish, pulses and cheese.

A protein molecule is made up of long chains of small units called amino acids. There are around 20 different amino acids, and they are joined together to long chains by special bonds. Different arrangements of the various amino acids give you different proteins.

The long chains of amino acids that make up proteins are folded, coiled and twisted to make specific 3d shapes. It is these specific shapes that enable other molecules to fit into the protein. The bonds that hold the proteins in these 3d shapes are very sensitive to temperature and pH and can easily be broken. If this happens the shape of the protein is lost and it may not function anymore in your cells. The protein is denatured.



Proteins carry out many functions in your body, they act as:

⇒ structural components of tissues such as muscles and tendons

⇒ hormones such as insulin

⇒ antibodies, which destroy pathogens and are part of the immune system

⇒ enzymes, which act as catalysts.

Deliberate Practice:

Use the information on the previous pages to complete the following tasks:

1. Fill in the gaps to complete the sentences:

Carbohydrates, _____**proteins**____, and lipids are food molecules. They are made up of smaller molecules joined together. Simple sugars are carbohydrates that contain only 1 or 2 sugar units. Complex carbohydrates, such as **starch/glycogen/cellulose**, contain long chains of simple sugar units bonded together.

Lipids consist of 3 molecules of fatty acids bonded to a molecule of __**glycerol**___.

Protein molecules are made up of long chains of ___**amino**_____ acids.

2. Complete the table to show information about carbohydrates, lipids and proteins:

Food Molecule	One food that is a good source	Use in the body	Molecules formed during digestion
Carbohydrates	**Pasta, rice, bread, sugary foods**	**Provide energy**	**Simple sugars (glucose)**
Lipids	**Butter, olive oil, nuts ad-**	**Provide energy, building new**	**Glycerol and fatty acids**
Proteins	**Meat, fish, nuts, dairy products, pulses**	**Forming new tissues, enzymes & hormones**	**Amino acids**

3. Hormone receptor molecules on the surface of cell membranes are protein molecules. The hormone fits into the receptor and triggers a response in the cell.

a) Explain why the shape of the receptor is important to its function

The hormone is the correct shape to fit into the receptor; it has to be the correct shape to trigger the response in the cell.

b) Suggest why the cell response to the hormone will not be triggered if the pH of the surroundings changes.

If the pH changes the bonds holding the shape of the protein chain of the receptor will be broken; the receptor will change shape (denature); the hormone will no longer fit into the receptor.

Required Practical Activity: Food Tests

You can identify the main food groups using standard food tests:

⇒ Carbohydrates: Iodine test for starch - yellow-red iodine solution turns blue-black if starch is present. Benedict's test for sugars - blue Benedict's solution turns brick red on heating if a sugar such as glucose is present.

⇒ Protein: Biuret test - blue Biuret reagent turns purple if protein is present.

⇒ Lipids: Ethanol test - ethanol added to a solution gives a cloudy white layer if a lipid is present.

Safety Considerations:

⇒ Ethanol is highly flammable and harmful, it should not be ingested or used near a naked flame.

⇒ Biuret solution is corrosive. Wear chemical and splash-proof eye protection.

Deliberate Practice:

You have been given a packet of dry soup. Describe the food tests you would carry out to find out of the soup contains starch, protein and glucose. You should include the reagents you would use plus the result if the test was positive.

Test for starch: add iodine to the dry soup; if starch is present it will go a blue-black colour.

Test for protein: add some of the soup to water and mix well, add Biuret solution and leave, if protein is present then a purple colour will be present.

Test for glucose: add some soup to water and mix well, add Benedict's solution and place in a water bath, if glucose is present then a brick red colour will be present.

Required Practical Activity—Food Tests

The Aim of the Practical:

To test different foods for the presence of glucose, protein, starch and lipids.

Experimental Methods:

Testing for Sugars:

1. Set up a water bath using a Bunsen Bu
2. Put some of the food sample into a te
3. Add a few drops of Benedict's solutio the test tube.
4. Put the test tube into the water bath at a minimum of 80°C for about 5 minutes.
5. Record any colour change in your results table.

Testing for Starch:

1. Put some of the food sample into a test tube.
2. Add a few drops of iodine solution.
3. Record any colour change in your table.

Testing for Lipids:

1. Put some of the food sample in a test tube.
2. Add a few drops of distilled water.
3. Add a few drops of ethanol.
4. Shake the solution gently.
5. Note your observations in your results table.

Testing for Protein:

1. Mix a sample of the food to be tested with 3cm3 of biuret solution.
2. Leave for 2 minutes
3. If the mixture turns a pale purple colour, the food contains protein.

Health & Safety:

- Ethanol is flammable and could catch fire.
- Boiling water can cause burns
- Reagents could ge skin
- Biuret solution is chemical and spla tion
- People could have

Sources of Error & Common Mistakes:

- Pre-grated cheese is coated in starch to stop it sticking together so will make iodine change to blue-black.
- For the glucose test, make sure you heat the reagents for long enough.
- You only need a small amount of the reagents—do not use more than the amount stated in the method.
- The colour change is hard to determine—you are looking for blue changing to purple.

What the examiner might ask:

- Qualitative test *(tell you just yes/no)* vs Quantitative *(tells you how much) tests.*
- Sources of error – *how could you make mistakes?* -
- Why is it hard to judge colour change accurately? -
- Resolution of measurements, repeatability, reproducibility etc
- Identify how we can measure small volumes accurately (use a pipette, syringe or burette or a 10ml measuring cylinder)

PPQs

Q1.

Sewers are often blocked by 'fatbergs'.

Fatbergs are made of very large lumps of fat and other solids.

The fat and solids come from waste being washed down drains and flushed down toilets.

The photograph below shows a person holding a small fatberg.

(a) The chemica

Describe ho

Test for fat _

(fat)
mix sample with ethanol and add (distilled) water
result must correspond with test
1

milky / white / cloudy (if fat is present)
1

Positive res

Test for pro

Positive res

(protein)
mix sample with Biuret (reagent)
*allow mix sample with Biuret A **and** Biuret B*
*allow mix sample with potassium / sodium hydroxide solution **and** copper sulphate solution*
1

mauve / purple / lilac / pink-purple (if protein is present)

(b) Some fats in fatbergs come from undigested food in faeces.

Most fat that humans eat is digested.

G

1

2

(b) fatty acid(s)
in either order
1

glycerol
1

Q2.

Four foods were tested for starch, sugar and protein.

The table shows the results.

Food	Test for starch: colour after iodine test	Test for sugar: colour after Benedict's test	Test for protein: colour after Biuret test
A	Blue-Black	Brick red	Blue
B	Orange	Blue	Lilac
C	Blue-Black	Yellow	Blue
D	Orange	Orange	Lilac

(a) Give **three** conclusions about food **D**.

(a) it does **not** contain starch

1

it contains sugar

ignore high / low amount

1

it contains protein

1

(3)

(b) Starch is broken down into glucose.

Which type of enzyme breaks down starch?

Tick (✓) **one** box.

Carbohydrase ★

Lipase ☐

Protease ☐

(1)

(c) Which part of a cell releases energy from glucose?

Tick (✓) **one** box.

Mitochondria ★

Nucleus ☐

Ribosomes ☐

Vacuole ☐

(1)

(d) Which food in the table above would be the most suitable for a person with Type 2 diabetes to eat?

Give **two** reasons for your answer.

Food _____

Reason 1 _____

_____

Reason 2 _____

_____

(d) B

*no marks if incorrect **or** no food given*

if no food written on answer line check the table

1

does not contain sugar

1

does not contain starch (that can be converted to sugar)

ignore references to protein

1

Q3.

An athlete decides to try a new type of protein drink after he exercises.

(a) The athlete tests the protein drink to check it contains protein.

Which solution is used to test for protein in the drink?

Tick **one** box.

Benedict's	☐
Biuret	★
Iodine	☐
Universal indicator	☐

(1)

(b) What colour will the solution turn to if there is protein in the drink?

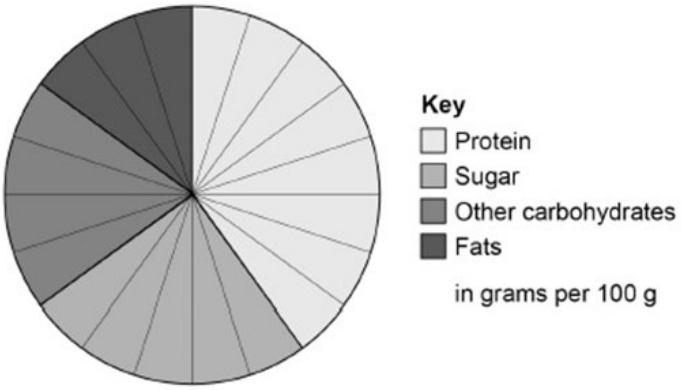
Tick **one** box.

Blue-black	☐
Purple	★
Red	☐
Yellow	☐

(1)

Figure 1 shows the proportion of different nutrients in the protein drink.

Figure 1



(c) What is the ratio of sugar to protein in the protein drink?

1:1 ☐ 1:0:6 ☐ 1:2 ☐ 1:1:6 ★

(1)

(d) Why is a high protein diet useful to an athlete?

Tick **one** box.

Provides amino acids to make new muscle. ★

Provides fatty acids to produce urea. ☐

Provides glucose for energy. ☐

Provides lactic acid for anaerobic respiration. ☐

(1)

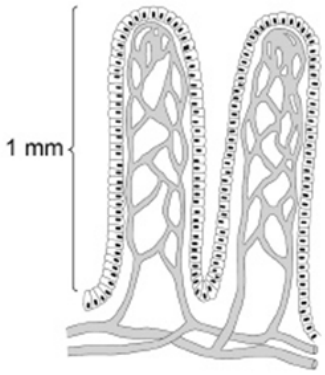
When the athlete drinks the protein drink the substances are digested.

The products of digestion are absorbed into the bloodstream.

Absorption happens in the small intestine.

Figure 2 shows a section of the small intestine.

Figure 2



(e) How is the small intestine in **Figure 2** adapted to absorb the products of digestion quickly?

Tick **two** boxes.

It has a large surface area. ★

It has a long diffusion pathway. ☐

It has a thin surface. ★

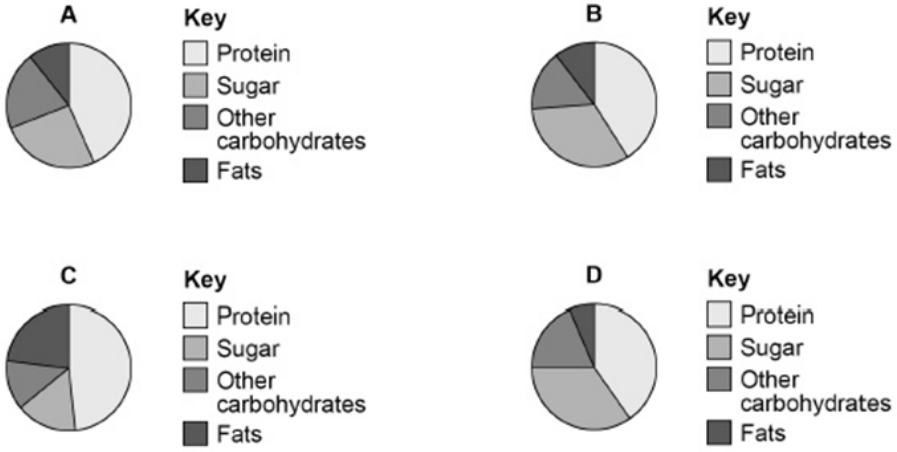
The concentration inside the small intestine is low. ☐

It has a poor blood supply. ☐

(2)

(f) **Figure 3** shows the proportion of different nutrients in four protein drinks.

Figure 3



Which protein drink should an athlete with diabetes use?

(f) **C**

1

lowest sugar (content)

1

(2)