Describe the role of Lipids in Living Organisms

Lipids are 'a large and varied group of organic compounds, (3) 'which are insoluble in water, but soluble in organic solvents such as ethanol and ether.' (7). The molecules contain atoms of hydrogen, carbon and oxygen. 'The ratio of hydrogen to oxygen atoms is always greater than 2:1.' (2)

'Triglycerides are fats and oils and are made when glycerol form condensation reactions with three fatty acids to produce ester bonds.' (2). At 20ºC fats are solids whereas oils are liquids. One of the major roles of lipids in organisms is the use of these fats as energy stores. 'Upon breakdown they yield 38 kJ/g of energy compared favourably with carbohydrates which yield 17 kJ/g,' (3) so they therefore store twice as much energy than carbohydrates. Animals store fat when hibernating and 'fat is also found below the dermis of the skin of vertebrates where it serves as an insulator.' (10). Plants usually store oils and a small mass for energy is used 'in plants where the dispersal of small seeds by wind or insects is much easier.' (9). Triglycerides are also 'compact, insoluble, can be stored at high concentrations, without requiring water as a solvent and are not mobilised as easily as carbohydrates,' (5) which makes them 'long term energy stores.' (5)

Fats also act as 'shock absorbing layers.' (2). This protects delicate organs such as the kidneys or the heart from physical damage. Aquatic mammals such as whales have 'extremely thick subcutaneous fat, called blubber.' (3). The blubber is extremely important in thermoregulation as underwater 'hair is ineffective as an insulation because it cannot trap water in the same way as it can air.' (10). Therefore as it is a poor conductor of heat, the layer of fat under the skin of aquatic mammals helps them to keep warm in cold climates. Fats aid buoyancy in aquatic mammals because they are less dense than water. This is especially true in vertebrates such as 'aquatic birds.' (2)

Lipids are used for electrical insulation in Schwann cells. 'The membranes of Schwann cells are largely composed of lipid and they do not contain the protein channels.' (9). The Schwann cells 'produce the fatty material myelin that surrounds the axons of many mammalian nerve cells.' (6)

'Triacylglycerols also release twice as much water as do carbohydrates when oxidised in respiration.' (5). A more indirect role of triacylglycerols is the use of their 'metabolic water, this is the water produced from their oxidation.' (5). This metabolic water is of vital importance, which include the 'development of very young reptiles when enclosed in eggshells or the daily metabolisms of animals such as camels, which live in habitats where water is scarce.' (5). Triglycerides are also commonly used in 'waterproof coverings.' (2). Oil coats animal skin to waterproof it along with fur and feathers so that water is repelled and the animal's insulation is not affected. However, 'insects and plant leaves use wax to form a waxy cuticle, which prevents water loss by evaporation and transpiration.' (9). The waxes are 'esters of fatty acids with long chain alcohols other than glycerols.' (10). Exoskeletons may also be coated with it. 'Saturated fatty acids that have no carbon-carbon double bonds have a high melting point and are found in animals whereas unsaturated fatty acids with one or more double bonds have lower melting points and are found in plants.' (4). These fatty acids are also used to derive plant scents, which attract insects and aid pollination.

Phospholipids are 'lipids containing a phosphate group and are formed when one of the primary alcohol groups of glycerol (head) forms an ester with phosphoric acid (tail), instead of a fatty acid.' (10). 'The presence of the phosphate group means that the charge on the head of the molecule is unevenly distributed. It is said to be polar and is attached to water. The head end of the molecule is described, as being hydrophilic (soluble in water). The hydrocarbon tails do not have this uneven charge distribution. They are therefore non-polar and will not mix with water. The tail end of

the molecule is described as being hydrophobic (insoluble).' (4). The main role of phospholipids in living organisms is that they are a major component of membranes and it is these solubility characteristics, which are of extreme importance in cells "because lipids tend to associate into non -polar groups and barriers, as in the cell membranes that form boundaries between and wit hin cells." (8). Therefore, if phospholipids were placed in water, they would arrange themselves 'into a phospholipid bilayer where the tails point inward and the heads outwards.' (7). This bilayer forms the basis of cell membranes. The membrane is partia lly permeable as water; water soluble and polar molecules cannot pass through whereas gases, lipids and non-polar molecules can. Other more minor roles of phospholipids in living organisms are in the 'transport of fat between gut and liver in mammalian di gestion and as a source of acetylcholine.' (5)

'Steroids are lipids whose molecules contain four rings of carbon and hydrogen atoms with various side chains.' (9). Steroids are common in all organisms, mainly as hormones. 'Phosphatidyl inositol (a phospholipid lacking the group esterified to the phosphate) acts to release inositol trisphosphate and diacylglycerol as intercellular second messengers to hormones.' (1). Terpenes are common in plants as pigments whereas cholesterol is the most common in humans. 'From cholesterol are made the bile salts, the sex hormones and the hormones of the adrenal cortex,' (5) 'aldosterone and cortisone.' (10). 'A steroid closely related to cholesterol occurs in the human skin and is converted to vitamin D by the ultraviolet rays in the sunlight.' (5)

Lipids also 'lower the surface tension in the air – breathing vertebrates to make breathing possible.' (11)

Therefore evolution development has facilitated the compartmentalisation of cells with the aid of phospholipids it can be considered as a vital compartment, which has enabled complex development and variation with birds fro example. Such variation as buoyancy, insulation etc are brought about by triglycerides.

Words (excluding title) = 999

Bibliography:

1. Introduction to Nutrition and Metabolism – David A. Bender 1997
2. AS Level Biology – Phil Bradfield, John and Judy Dodds and Norma Taylor 2001
3. Understanding Biology for Advanced level – Glenn and Susan Toole 1999
4. A new Introduction to Biology – Bill Indge, Martin Rowland and Margaret Baker 2000
5. Advanced Biology – C J Clegg with D G Mackean 1994
6. A-Z Biology Handbook – B. Indge 1997
7. Cell Biology and Genetics – John Adds, Ruth Miller and Erica Larkcom 1996
8. http://ntri.tamuk.edu/cell/lipid.html
9. Biology – Martin Rowland 1992
10. Biological Science 1 – Green, Stout and Taylor
11. New Scientist Journal – 11th October 1997 p.21 – Kurt Kleiner