A concentrated energy reserve

Triglycerides contain three fatty acid chains joined to glycerol. Their long hydrocarbon regions make them effective stores of fuel for later respiration.

FROM A STORED LIPID TO USABLE ENERGY

TRIGLYCERIDE

Stored chemical energy

↓

GLYCEROL + FATTY ACIDS

Released by hydrolysis of ester links

↓

RESPIRATION

Oxidation supports ATP production

1. MANY C-H BONDS; RELATIVELY LITTLE OXYGEN

Fatty acid chains are more reduced than carbohydrates: their carbon atoms are rich in hydrogen and less associated with oxygen. Oxidising this fuel can release more energy per unit mass than oxidising carbohydrate.

2. HIGH ENERGY YIELD PER GRAM

Fat yields roughly twice as much energy per gram as carbohydrate on a dry-mass basis. A large reserve can therefore be carried with less fuel mass. This is useful for prolonged fasting, hibernation or sustained activity.

3. BREAKING A BOND IS NOT THE ENERGY SOURCE

Breaking chemical bonds requires energy. Net energy is released by the overall oxidation process, including formation of lower-energy products. Hydrolysis of the three ester links alone is not the full energy-yielding pathway.

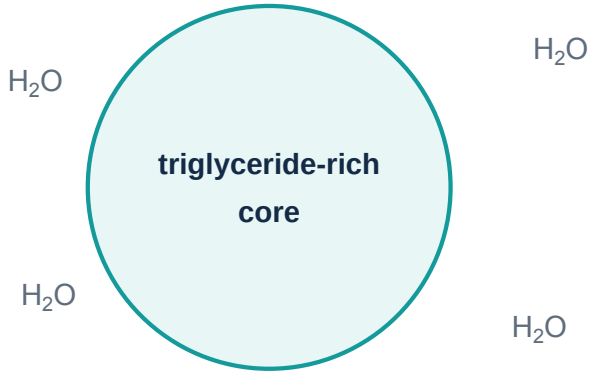
Supporting reading: The Cell, Metabolic Energy (NCBI Bookshelf).

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 10, p. 18.

Store fuel without much water

Hydrophobic triglycerides separate from the watery cytoplasm into lipid droplets. Their storage properties follow from their predominantly non-polar hydrocarbon regions.

A LIPID DROPLET IN AN AQUEOUS CELL



The core contains little water compared with hydrated glycogen.

Diagram is schematic: the droplet surface layer and associated proteins are omitted.

A concentrated reserve, not many freely dissolved sugar molecules.

1. LITTLE ASSOCIATED WATER: LOWER STORAGE MASS

Triglycerides are stored in a nearly water-free form, whereas glycogen is stored with substantial associated water. Less water needs to be carried per unit of stored fuel, adding to fat's advantage as a concentrated energy reserve.

2. LOW OSMOTIC IMPACT

Insoluble triglycerides do not form a large population of individually dissolved molecules in the cytoplasm. A substantial reserve can accumulate without the large reduction in water potential that an equivalent reserve of free glucose would cause.

3. A RESERVE IN BOTH ANIMALS AND PLANTS

Animals store triglycerides in adipose tissue. Many seeds contain oil droplets that provide fuel during germination, before the seedling can supply enough carbohydrate by photosynthesis. Stored fat must first be mobilised and metabolised to be used.

Supporting reading: DGAT enzymes and triacylglycerol biosynthesis (PMC).

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 10, p. 18.

Physical properties, useful roles

Triglyceride-rich deposits also serve physical functions. Distinguish the properties of the lipid molecules from the effects of the whole fat-containing tissue.

THERMAL INSULATION: SLOWER HEAT TRANSFER



Fat-rich tissue conducts heat poorly. A layer beneath the skin adds resistance to heat flow from the body to a colder environment.

1. INSULATION REDUCES HEAT LOSS

Subcutaneous fat can help maintain body temperature by slowing heat transfer. It does not stop heat loss completely. Insulation is different from heat production: producing heat requires metabolism.

2. CUSHIONING PROTECTS TISSUES

Fat-containing tissue forms deformable padding around some organs, such as the kidneys. The tissue spreads or absorbs mechanical forces, reducing injury from pressure and impacts. A single triglyceride molecule is not itself an organ-sized cushion.

3. LOW DENSITY CAN AID BUOYANCY

Fat is less dense than water. Lipid-rich stores can therefore reduce average body density and contribute to buoyancy in some aquatic animals. Floating still depends on the density of the whole animal, not just the amount of fat.

Keep the link explicit: molecular structure → physical property → biological function.

Supporting reading: OpenStax Anatomy and Physiology, 4.3 Connective tissue.

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 10, p. 18.