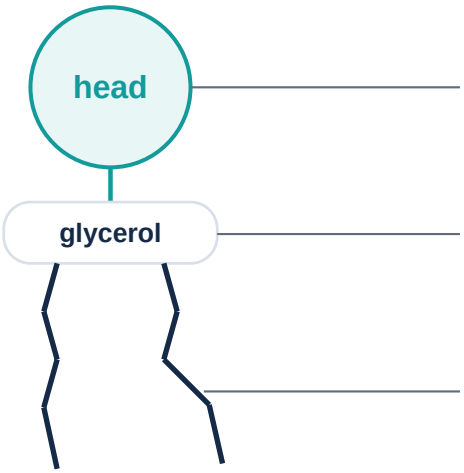
One molecule, two different regions

A phospholipid is amphipathic: it has a hydrophilic region and a hydrophobic region. This combination is the key to its behaviour in water.

THE GLYCEROL-BASED PHOSPHOLIPID MODEL



PHOSPHATE-CONTAINING HEAD

Polar and hydrophilic; interacts with water.

GLYCEROL BACKBONE

Connects the head and two tails.

TWO FATTY ACID TAILS

Non-polar hydrocarbon regions; hydrophobic.

A schematic, not an atom-level formula. Tail lengths and shapes vary.

1. COUNT THE COMPONENTS

In this model, two fatty acids are joined to glycerol by ester linkages. A phosphate-containing group occupies the third position. The head often also contains another polar group, such as choline; the circle is not a single atom.

2. EXPLAIN EACH REGION

The phosphate-containing head has polar or charged groups that interact favourably with water. The tails are dominated by C-C and C-H bonds and do not mix readily with water. Do not describe the whole molecule as entirely hydrophobic.

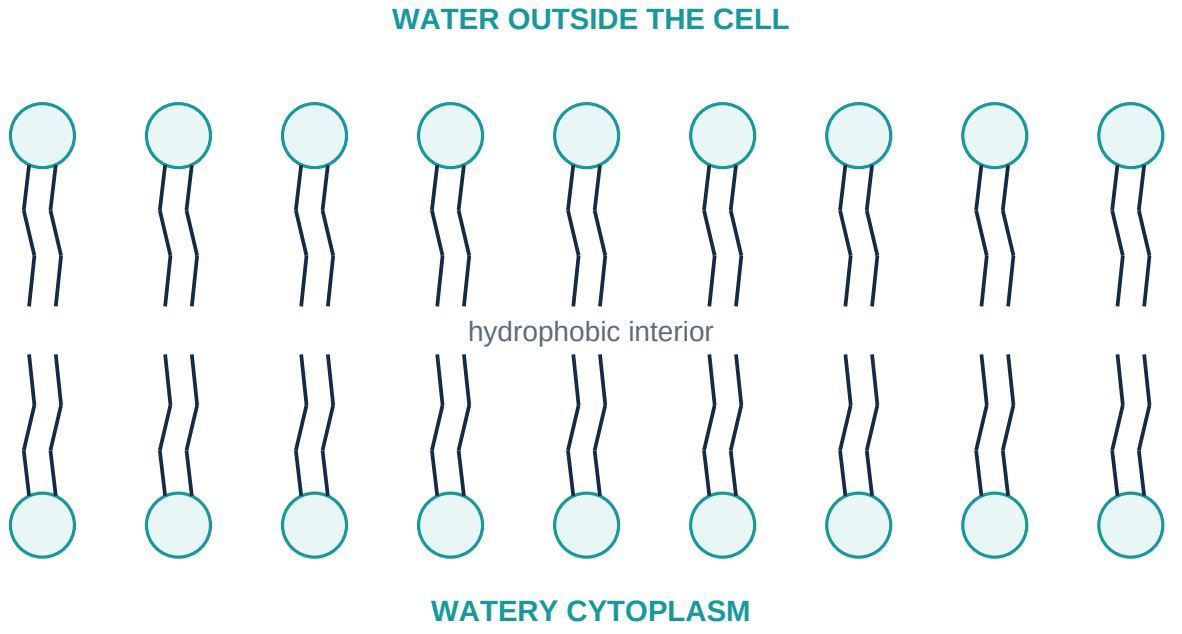
Compared with a triglyceride: two fatty acid tails plus a phosphate-containing head, rather than three fatty acid chains. This is a structural comparison, not a one-step conversion reaction.

Supporting reading: OpenStax Biology 2e, 3.3 Lipids.

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 11, p. 18.

Water on both sides: a bilayer

In an aqueous environment, phospholipids can assemble into two layers. Heads face water on each side, while the tails are sheltered together in the interior.



Each circle with its two tails represents one phospholipid. The drawing omits proteins and other membrane components; a real membrane is not made only of phospholipids.

1. HEADS FACE WATER; TAILS FACE TAILS

Both surfaces of the bilayer are hydrophilic. The inner core is hydrophobic. A tail does not point into the cytoplasm simply because it belongs to the inner layer: cytoplasm contains water, so the inner-layer heads face it.

2. ASSEMBLY DOES NOT REQUIRE NEW COVALENT LINKS

The arrangement reduces exposure of non-polar tails to water. Phospholipids remain separate molecules, held in an organised assembly by non-covalent interactions. The bilayer is not a polymer joined by new ester bonds.

Application to membranes: bilayers can close into boundaries around cells or compartments, avoiding exposed hydrophobic edges.

Supporting reading: OpenStax Biology 2e, 5.1 Components and structure.

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 11, p. 18.

A fluid, selective boundary

The phospholipid bilayer provides the basic barrier of cell surface membranes and many organelle membranes. Its hydrophobic centre helps separate aqueous compartments.

TWO RELATED LIPIDS, DIFFERENT MAIN ROLES

Feature	Triglyceride	Phospholipid model
Fatty acid chains	Three	Two
Phosphate head	Absent	Present
Overall character	Hydrophobic	Amphipathic
Typical arrangement	Lipid droplet core	Membrane bilayer
Main role here	Energy reserve	Compartment boundary

1. THE CORE IS NOT EQUALLY PERMEABLE TO EVERYTHING

Small non-polar molecules such as oxygen and carbon dioxide can cross the lipid region relatively easily. Ions and most large polar molecules cross it poorly and usually need membrane transport proteins.

2. SELECTIVE DOES NOT MEAN WATERPROOF

Some water crosses the lipid bilayer, and aquaporin channels can greatly increase water movement. Selective permeability depends on the bilayer and its proteins together; phospholipid heads alone do not choose which substances enter.

3. FLUID DOES NOT MEAN DISORGANISED

Phospholipids can move laterally within a layer while the two-layer arrangement is maintained. Cis-unsaturated tails tend to prevent tight packing, helping maintain fluidity at a given temperature.

Supporting reading: OpenStax Biology 2e, 5.2 Passive transport.

Scope: Cambridge Biology 9700 syllabus, section 2.2, outcome 11, p. 18.