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# Lipid freight

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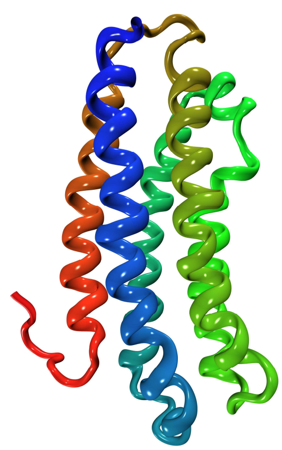
**Life is not static. Despite the apparent coolness of living matter's external features – save for the twitch of an insect's antenna or the flick of a chameleon's tongue – our insides are seething. Molecules of all shapes and sizes are being frantically – and continuously – ferried from one part of our body to another by way of an intricate mesh of highways and side roads which bear as many sign posts and traffic regulations as any regular metropolis. When humans need to go from A to B, they climb into a car, hop onto a bus or thumb a ride. What kind of transport do proteins use? Or other biomolecules? Well, there seem to be as many means of 'biotransport' as there are makes of car. And one is the Lipid Transfer Particle (LTP), a lipid shuttle found in insects, the scaffolding of which depends on a particular type of protein: the lipophorins.**

Lipid Transfer Particles were discovered over 25 years ago. They are supposedly spherical in shape, although some have suggested that they have a spherical 'head' and a small cylindrical tail, a little like the general aspect of sperm. The head – everyone agrees however – is where it is all happening. If you were to slice an LTP, you would distinguish two main layers. An outer layer made up of phospholipids and proteins, and an inner core in which are stored different kinds of fat but also – to a lesser degree – biomolecules such as hydrocarbons, carotenes and even hormones. The whole concept of LTPs is to find a way for insoluble molecules to be carried from one cell to another – or one tissue to another – through an aqueous intercellular medium which they could not cope with otherwise. Nature has its ways.

The scaffolding of the outer core of LTPs is held together by a monolayer of phospholipids and proteins known as the apolipophorins: apolipophorin I, apolipophorin II and, in certain circumstances, apolipophorin III. Apolipophorins I and II are derived from their precursor proapolipophorin which, in insects, is synthesized in the fat body – the tissue in which is stored the insect's supply of fat. There is only one apolipophorin I and one apolipophorin II peptide per LTP. LTPs emerge from the fat body fully formed – phospholipids, lipophorins and various core lipids included – and probably mature as they pass through the midgut tissue where a little more lipid is added for good measure. Apolipophorin III is synthesized independently and can be found in many copies on the outer shell of certain LTPs. Its role seems to be one of 'expansion' where, by binding to the outer shell of an LTP, it can unfold and spread out, thus offering the LTP the possibility of expanding so that it can carry more stuff!



Apolipophorin III

Courtesy of Fabrice David, SIB Geneva

Why do lipids need to travel from one tissue to another in the first place? Lipids in living organisms are stored energy. The fat bodies of insects synthesize lipids which then need to be distributed to various tissues so that they – in turn – can get on with their various chores. Lipids do not like the media between tissues so they need a way to travel. And LTPs are an answer. An excellent illustration of lipid uptake is flight. Flight is one of the most energy-demanding processes in nature and lipids provide the major energy source. It is in such instances that apolipophorin III makes an appearance. The demand for fat is so great that one way of stashing more lipid into an LTP is by expanding it thanks to the litheness of apolipophorin III.

Though lipids use LTPs extensively as taxis, so do a number of other molecules such as hydrocarbons needed for the insect's cuticle or even juvenile hormones needed for its development. As a result, LTPs are vital for an organism's proper function and have as many missions – in the long run – as they do passengers.

How LTPs find their targets is still a mystery. There must be some kind of receptor on the surface of a specific tissue awaiting a specific ligand on the LTP. A recent discovery may have offered a clue. There are proteins known as 'morphogens'. Morphogens have an effect on a cell's function once they have reached a certain gradient within the cell. How some morphogens manage to travel great distances has puzzled scientists for decades. Recently, researchers spotted a couple of morphogens which hitch a ride on certain LTPs, by hooking onto the monolayer of phospholipids on their surface. The LTP is then directed to a specific cell which probably bears a receptor to which the morphogen binds and is subsequently internalised via endocytosis. It could be that lipids go from one cell to another in the same way and that some kind of lipase is activated and snips the lipid away from the LTP. As a consequence, LTPs are neither damaged nor indeed internalised but can scuttle off and continue their job elsewhere.

So, besides giving a clue as to how lipids evolve from one place to another, it seems that LTPs are not only used for lipid distribution but also for protein transport. Which is a novelty. It is now clear that LTPs are used for the distribution of specific components in insects and have a direct role in maintaining vital functions, one of which is the proper distribution of energy within an organism. As a consequence, there is no doubt that 'designer LTPs' designed to address specific problems will become a growing interest. As an example, LTPs can be problematic in the fight against insects which destroy crops or transmit diseases, because they lap up pesticides thus making them harmless. To date, LTPs are best known in insects. Mammals also have their means of molecular transport but they are not so well defined. However, there is a great chance that mammalian lipid freight reflects in many ways that of insects. Time will tell.

## Cross-references to Swiss-Prot

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Apolipophorin III, *Manduca sexta* (Tobacco hornworm) : P13276
Apolipophorin precursor (Apoliphorin I and II), *Locusta migratoria* (Migratory locust) : Q9U943
Apolipophorin III, *Locusta migratoria* (Migratory locust) : P10762

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