Compartmentation of metabolic events

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This article has been translated from WikiSkripta; ready for the **editor's review**.

The eukaryotic cell is divided by **semipermeable membranes** into several **compartments**. They differ from each other in, for example, enzymatic equipment or membrane transporters. The pH values are also different - enzymes often have different pH optima. If there was only one space in the cell, some of the enzymes would probably not be functional or the catalysis mediated by them would not be efficient enough.

🔎 *For more information see Compartmentation of Metabolic Pathways (FBLT) .*

Overview of metabolic pathways according to the compartments in which they take place

Cell partition	Metabolic pathways
Cytoplasm	Carbohydrate metabolism: glycolysis, part gluconeogenesis, glycogenolysis and glycogen synthesis, pentose cycle Fatty acid metabolism: fatty acid synthesis Amino acid metabolism: synthesis of non-essential AMK, some transaminations Other pathways: part of the heme and urea synthesis pathways, purine and pyrimidine metabolism
Mitochondria	Carbohydrate metabolism: pyruvate dehydrogenase complex, beginning of gluconeogenesis (conversion of pyruvate to oxaloacetate) Fatty acid metabolism: β-oxidation of MK, synthesis of ketobodies (only liver cells), degradation of ketobodies (only extrahepatic tissues) Metabolism of amino acids: oxidative deamination of glutamate, some transaminations Other pathways: Krebs cycle, respiratory chain and oxidative phosphorylation (on the inner mitochondrial membrane), part of heme and urea synthesis
Smooth endoplasmic reticulum	Synthesis of triacylglycerols and phospholipids Elongation and desaturation of fatty acids Part of the synthesis steroids Biotransformation xenobiotics Conversion of glucose-6-phosphate to glucose (in tissues where glucose-6-phosphatase occurs)
Rough endoplasmic reticulum	Proteosynthesis (translation of mRNA) Post-translational modifications (oxidation, cleavage, methylation, phosphorylation, glycosylation)
Golgi apparatus	Post-translational modification of proteins (glycosylation, ...) Sorting of proteins and formation of secretory vesicles
Lysosomes	Hydrolytic cleavage of proteins, carbohydrates, lipids and nucleic acids
Peroxisomes	Degradation of MK with a long chain (from 20 carbons)
Kernel	DNA replication and transcription Synthesis of RNA
Seed	RNA editing Synthesis of ribosomes
Ribosomes	Protein synthesis

We also observe a different distribution of substrates and products in different compartments of the cell. Even some coenzymes cannot pass freely between compartments, e.g. NADH or coenzyme A molecules do not pass through the inner mitochondrial membrane. Many enzymes need a suitable coenzyme for their catalytic function. By changing the concentration of a coenzyme in a certain compartment, a certain metabolic pathway can be turned on or off. Compartmentation also facilitates the *regulation of conflicting events*.

E.g. the synthesis of fatty acids takes place in the cytoplasm, while their degradation takes place in the mitochondria. The speed of reactions depends on

- supply of substrates, or cosubstrates (coenzymes),
  - from the previous steps of the metabolic pathway,
  - by transport from other compartments,
- pumping out products
  - further steps of the metabolic pathway,
  - by transport to other compartments.

> *E.g. The Krebs cycle would stop if the NADH it forms is not used up in the respiratory chain. The respiratory chain reoxidizes NADH to NAD^+, which re-enters the Krebs cycle as a coenzyme.*
>
> *Sometimes an excess of citrate is produced in the mitochondria. The latter can be transported into the cytoplasm, where it acts as a regulatory molecule.*

Reactions that directly follow each other in metabolism often take place on enzymes that are in close proximity. Examples can be the reactions of the already mentioned Krebs cycle or the respiratory chain. The grouping of reactions into one compartment increases the speed of metabolic pathways, as the product of one reaction accumulates directly in the place where it serves as a substrate for subsequent reactions.

Compartmentation allows sensitive and targeted control of metabolic pathways that take place in one place without affecting processes in another part of the cell.

> Compartmentation places increased demands on the energy consumption of the cell. The transport of substances across membranes often goes against the concentration gradient and must use '*ATP-dependent transporters*.