Compartmentalization of metabolic pathways

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Nutrients in cells - call these compounds
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- Waste product
- It is not energy
- Substrate
- Waste product
Where the nutrients are metabolised within a cell?

The figure is found at http://fig.cox.miami.edu/~cmallery/150/proceuc/c7x7metazoan.jpg (May 2007)
Main pathways of an intermediary metabolism

• glycogenesis
• gluconeogenesis
• lipogenesis
• synthesis of FA
• ketogenesis
• proteosynthesis
• urea synthesis

• glycogenolysis
• glycolysis
• lipolysis
• β-oxidation
• degrad. of ketone bodies
• proteolysis
• degrad. of amino acids

CITRATE CYCLE, RESPIRATORY CHAIN
Cytoplasm

- cytosol is an aqueous solution
- accounts for 50% of the cellular volume
- contains enzymes of majority mtb pathways
- some specific pathways are localized in organells (surrounded by membrane)
- storage compounds form inclusions (not surrounded by membrane)
Cytoplasm

- glycolysis
- gluconeogenesis (from oxaloacetate or glycerol)
- metabolism of glycogen
- pentose cycle
- synthesis of fatty acids
- synthesis of nonessential amino acids
- transamination reactions
- synthesis of urea (a part; only in the liver!)
- synthesis of heme (a part)
- metabolism of purine and pyrimidine nucleotides
Mitochondrion

- pyruvate dehydrogenase complex (PDH)
- initiation of gluconeogenesis
- β-oxidation of fatty acids
- synthesis of ketone bodies (only in the liver!)
- oxidative deamination of glutamate
- transamination reactions
- citrate cycle
- respiratory chain (inner mitochondrial membrane)
- aerobic phosphorylation (inner mitoch. membrane)
- synthesis of heme (a part)
- synthesis of urea (a part)
Endoplasmic Reticulum

**Smooth ER**
- synthesis of triacylglycerols and phospholipids
- elongation and desaturation of fatty acids
- synthesis of steroids
- biotransformation of xenobiotics
- glucose-6-phosphatase

**Rough ER**
- proteosynthesis
  
  *(translation and posttranslational modifications)*
Golgi Apparatus

• posttranslational modification of proteins
• protein sorting
• export of proteins (*formation of vesicules*)

Ribosomes

• proteosynthesis

Nucleus

• replication and transcription of DNA
• synthesis of RNA
Lysosomes

- hydrolysis of proteins, saccharides, lipids and nucleic acids
- pH of 4.5 - 5.0

Peroxisomes

- oxidative reactions involving $O_2$
- use of hydrogen peroxide $\rightarrow$ CATALASE
- degradation of long chain FA (from $C_{20}$)
Compartmentalization of mtb pathways in a regulation of metabolism

- various enzyme distribution
- various distribution of substrates and products (~ transport)
- transport of substrates / products
- transport of coenzymes - not common
- subsequent processes are close to each other
multienzyme complexes

separate enzymes of a mtb pathway

This is Figure 17.6 from Garrett, R.H.; Grisham, C.M. Biochemistry; Saunders: Orlando, 1995; page 553, found at http://www.uwsp.edu/chemistry/tzamis/enzyme_complex.html (December 2006)
example: 2-oxoacid dehydrogenase multienzyme complex

The figure is found at: http://faculty.uca.edu/~johnc/pdhrxns.gif (December 2006)
Transport of compounds between compartments

The inner mitochondrial membrane is impermeable for:

- acyl-CoA, NADH and oxaloacetate

- Acyls of fatty acids are transported via carnitine transporter (CoA is not transported)

- Acetyl-CoA is transformed to citrate which can be then transported to cytosol (CoA is not transported)

  \[ \text{acetyl-CoA} + \text{oxaloacetate} \rightarrow \text{citrate} + \text{CoA} \]

- NADH reduces other compound which then „transports“ hydrogens through the membrane - reoxidation of it proceeds in mitochondrion (NAD is not transported)
In a human metabolism

a) glucose is oxidized and cleaved to two pyruvates

b) fibre in a diet is one of sources of blood glucose

c) milk lactose is a source of fructose

d) ribose from food is an important substrate for nucleotide synthesis in human cells
In a human metabolism

a) glucose is oxidized and cleaved to two pyruvates  YES

b) fibre in a diet is one of sources of blood glucose    NO

c) milk lactose is a source of fructose               NO

d) ribose from food is an important substrate for nucleotide synthesis in human cells  NO
Choose a correct statement(s)

a) fat in a diet is composed mainly of triacylglycerols

b) long chain fatty acids are water soluble compounds

c) unsaturated fatty acids yield more energy than saturated fatty acids

d) linoleic acid is an essential fatty acid
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Choose a correct statement(s)

a) proteins are not essential in a diet because cells can synthesize their own proteins

b) cysteine contains by two chemical elements more than glucose

c) when amino acids are degraded ammonia is produced

d) amino acids can be converted to fat in a human body
Choose a correct statement(s)

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NEXT SEMINAR: Important terms in enzymology