Outline – Respiration and Lipid Metabolism

1. Review of Aerobic Respiration
2. Carbon sources in glycolysis
3. Metabolism of PEP and pyruvate
4. Oxidative pentose phosphate pathway
5. Malate oxidation
6. Electron Transport

Aerobic Respiration - Review

- 6C Sugar conversion to 5C sugar
- Synthesis of 3C to 7C sugars
- Synthesis of organic acids
- Lipid breakdown in glyoxysome
- Organic acid synthesis in mitochondria
- Gluconeogenesis in cytoplasm

Glycolysis – Carbon sources

- Glucose → Pyruvate
- Glycolysis
- Pathways to metabolize PEP & Pyruvate
- Fermentative Metabolism

Oxidative Pentose Phosphate Pathway

- Functions
  1. Supplies NADPH for biosynthesis
  2. Reduces O₂ for ATP synthesis in mitochondria
  3. Biosynthetic substrates for RNA & DNA, lignin & flavonoids, aromatic amino acids
  4. Produces Calvin cycle intermediates before greening
Citric Acid Cycle oxidation of malate

Malate + NAD⁺ → Oxaloacetate + NADH

Malate + NAD⁺ → Pyruvate + CO₂ + NADH

From mitochondrion → Into cytosol

Functions:
1. Complete oxidation of Krebs cycle intermediates
2. Regulation of malate levels in cell (malate can be stored in vacuole ... e.g. CAM plants)

Electron Transport Pathway

Start Mon

Electron Transport Pathway in Plants

1. Multiple NADH dehydrogenases
2. Alternative Oxidase

Outline – Lipid Metabolism

1. Functions of lipids in plants
2. Triacylglycerols, glycerophospholipids & glyceroglycolipids
3. Lipid synthesis
4. Lipid degradation
Lipid Functions

1. Carbon storage
   Seeds e.g. commercial oils: sunflower, soybean, peanut, cotton
   Fruits e.g. avocado, olives

2. Energy Storage – same as above

3. Energy harvest – chlorophylls & carotenoids

4. Membranes – phospholipids

5. Protection – waxes

6. Hormones – isoprenoids → precursors to some hormones (ABA & GA)
   metabolic products (natural rubber)
   steroids & tocopherols

7. Intracellular signalling
   linolenic acid → jasmonate → activates defenses against
   fungal & insect pathogens
   anther & pollen development

Lipid Storage

1. Oil bodies store lipids = spherosomes or oleosomes
   Half-bilayer membrane
   single layer of phospholipids formed from ER
   Oleosin proteins stabilize membrane

Triacylglycerols

1. Glycerol + 3 fatty acids (acyl groups)
2. Fatty acids: 12 – 20 carbons, mostly 16-18
3. Oils ≈ unsaturated fatty acids
4. Fats ≈ mostly saturated fatty acids

TABLE 11.3

<table>
<thead>
<tr>
<th>Saturated Fatty Acids</th>
<th>Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linoleic acid (18:2)</td>
<td>C8H17COO-CH(=CH-CH2)COO-CH3</td>
</tr>
<tr>
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<td>C8H17COO-CH(=CH-CH=CH2-CH2-CH=CH-CH2)COO-CH3</td>
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Note:

11.16 Cycle of fatty acid synthesis in plastids of plant cells

Lipid composition (percentage of total)

<table>
<thead>
<tr>
<th>Lipid composition</th>
<th>Chloroplast</th>
<th>Endoplasmic reticulum</th>
<th>Mitochondrion</th>
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<tr>
<td>Phosphatidylcholine</td>
<td>4</td>
<td>47</td>
<td>43</td>
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<tr>
<td>Phosphatidylethanolamine</td>
<td>—</td>
<td>34</td>
<td>35</td>
</tr>
<tr>
<td>Phosphatidylinositol</td>
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<td>7</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Dipalmitoylphosphatidylglycerol</td>
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Structural features of triacylglycerols and polar glycerolipids

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<th>glycerophospholipid</th>
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<tr>
<td>X = CH3</td>
<td>CH3(OH)</td>
<td>C8H17COO-CH(=CH-CH2)COO-CH3</td>
<td>Phosphatidylethanolamine</td>
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Glycerophospholipids

Glycerolipids

TABLE 11.4

Glycerolipid components of cellular membranes

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Biosynthesis of Glycerophospholipids & Glyceroglycolipids

- Acetyl CoA
  - Acyl Carrier Protein
    - Condensation to fatty acids-ACP
      - 100% in Chloroplast

Glycerophospholipids
- Digalactosyldiacylglycerol
- Phosphatidic acid
- Phosphatidylethanolamine
- Diphosphatidylglycerol
- Monoacylglycerol
- Glycerol-3-Phosphate

Glyceroglycolipids
- Acyl Carrier Protein
- Different Acyl Carriers

Lipid Conversion to Carbohydrates

- B-oxidation of fatty acids
  - Oil Bodies
  - Triacylglycerol hydrolysis to free fatty acids

- Oilseed
- Germination
- Growth

- Sucrose
- Glucose
- Gluconeogenesis
- Cytosol

- Mitochondrion
  - Succinate
  - Glyoxylate cycle

- Oil bodies

Lipid Conversion to Carbohydrates

- Respiration & Lipid Metabolism

END

END

Respiration & Lipid Metabolism