**Metabolic Relationships of Fungi with Oxygen**

| | | |
|---|---|---|
| Majority | = | obligate aerobes |
| Many | = | facultative anerobes |
| Some | = | obligately fermentative |
| Few* | = | obligately aneroblic |

* Only recently discovered among animal gut organisms. Therefore, may be many that yet need to be discovered.

447

---

**Major Respiratory Pathways Associated with Obligately Aerobic Fungi**

1. Glycolytic/Embden, Meyerhoff, Parnas (EMP) pathway
2. Pentose phosphate (PP) pathway
3. Entner Doudoroff (ED) pathway
4. Tricarboxylic acid (TCA) or Krebs cycle pathway*

* Operates in conjunction with an electron transport chain that dictates that oxygen acts as the final electron/hydrogen acceptor. (see pp. 14 and 15 of handouts)

448b

---

***Aqualinderella fermentans***

1. [$O_2$] does not affect amount of lactate produced
2. [$O_2$] does not affect amount of glucose consumed
3. [$O_2$] does not affect amount fungus grows or at rate it grows*

*no concentration dependency of biomass production on [$O_2$*] as seen with other fungi.

Thus, obligate fermentative fungus, as *Leucosporidium (Candida) stoffii* & RD mutants of *S. cereviseae & N. crassa*

453

---

**Stage I Events** - Conversion of C-6 compounds to appropriate forms and their subsequent phosphorylation.

a. ATP requiring step.

**Stage II Events** - Degradation of the phosphorylated C-6 compounds to $C_3$ compounds by various pathways.

a. These degradation steps can result in the release of no more than 1/3 of the original free energy of the hexose.

454

---

**Stage III Events - Degradation of the C-3 compounds to the C-1 compound $CO_2$**

a. These events (Stage III) bring about the formation of numerous intermediates which can be used as substrates for anabolic processes or they can accumulate; e.g., citric acid.

b. Release of most of remaining free energy of the original hexose molecule.

455

---

**Stage 1 Phosphorylation**

Hexokinase*

* Constitutive in yeast & probably other (all?) fungi having enzyme - *S. cereviseae* 2 isoenzymes

* Specificity low = will phosphorylate D-fructose, 5-beta-D-fructose, 2 deoxy-D-glucose, mannose, D-glucosamine

456a

---

**Primary Accumulated Metabolism**
**("overflow metabolism")**

Caused by metabolic lesions (disruptions in normal enzyme system caused by mutation or abnormal growing conditions with strain having selected enzymes)

A B C D

stressed enzyme (low Km)

C overflow trapped inside of cell or released into medium

*examples ethanol, citric acid, phenylalanine, etc., etc., etc.

470

## Conditions for Citrate Production

1. high glucose (15 - 20%)
2. low pH ( 2- 4.5)
3. high aeration
4. NH4 NO3 [ ] of 2-2.5 g/l

Main agent of production*

*Aspergillus niger*

world wide 1978 175,000 tons/year

*see handout p. 30

471

## Secondary Metabolites*
## ("shunt metabolites")

Compounds produced by microorganisms having no known function in cells and little or no known economy for cells.

* Production often has little or no taxonomic relevance

Examples: penicillins, cephalosporins, cytochalasins, aflatoxins, griseofulvin, etc.

472

## Why $2^0$ Metabolites Arise?

1. Biochemical pathway lesions

2. Biosynthesis of waste products

3. Biosynthesis of detoxifying agents from deleterious products

4. Biosynthesis of compounds, which are products of chance events

5. Biosynthesis of regulators produced in excess

6. Biosynthesis of unusual compounds produced in excess, which are important in development

7. Virus or plasmid-mediated products of metabolism

473

**Tropophase**

1. The exhaustion of an essential nutrient which leads to the termination or near termination of cellular proliferation (balanced phase)

**Idiophase**

2. The accumulation of primary intermediates of metabolism (storage phase)

3. The triggering of the induction of enzymes necessary for secondary biosynthesis by these intermediates, or the activation of enzymes formed during tropophase, which lead to product formation (maintenance phase)

475

---

**Types of Fungal Culture Media**

1. Natural - medium represents essentially unmodified plant or animal material

   a. complete - seeds, fruit, twigs, vegetable slices, pollen, dung, hair, exoskeleton, etc.

   b. partially processed - malt or yeast extract, potato extract, tomato juice, cornmeal, peptone, corn steep.

2. Semisynthetic - media with mixtures of partially processed plant &/or animal products & known pure chemicals - e.g., YPG, CMDP, Subaurauds, etc.

3. Synthetic - media with all ingredients chemically defined - e.g., Vogals synthetic, Westegard's synthetic cross, Czapeks Dox, etc.

480

---