Area: Microbial Structure

Microorganism: *Paracoccus denitrificans*

Reference: Nauyalis, P. A., Hindahl, M. S., and Wilkinson, B. J. 1985. Isolation, characterization and protein and polar lipid compositions of *Paracoccus denitrificans* outer membrane. Biochimica et Biophysica Acta 840: 297-308.

The cell membrane and the outer membrane of Gram-negative bacteria differ in biochemical structure and function. *Paracoccus denitrificans* is a Gram-negative bacterium that has been extensively studied because it carries out respiration in a way that is very similar to that found in mitochondria. To study the composition of the cell membrane and the outer membrane of *P. denitrificans*, Nauyalis, Hindahl, and Wilkinson (Biochim. Biophys. Acta 840: 297-308, 1985) disrupted the bacteria mechanically and subjected the broken cells to high-speed centrifugation. They collected two membrane fractions and then analyzed their composition.

component fraction A fraction B

protein (µg/mg) 623 501

lipid (µg/ml) 515 321

carbohydrate (µg/ml) 11.6 40

KDO (µg/ml) 2.3 5.7

hexosamine (µg/ml) 1.8 12.4

NADH dehydrogenase 119 trace

(units/mg protein)

succinate dehydrogenase 460 29

(units/mg protein)

1. Which of the following statements best describes the organization of the proteins and lipids in these membranes?

a. The lipids form a bilayer with the proteins bound to the inner and outer surfaces.

b. The proteins form an inner layer with the lipids bound to the surfaces.

c. The lipids form a bilayer with the proteins either inserted into the bilayer or bound to their surfaces.

d. The lipids and proteins are randomly organized into a continuous layer.

2. The space between the cell membrane and the outer membrane in a Gram-negative bacterium is referred to as:

a. the cytoplasm

b. the periplasm

c. the epiplasm

d. the extracellular space

3. The compound KDO (2-keto-3-deoxyoctonic acid) is almost exclusively found in the lipopolysaccharides characteristic of Gram-negative bacteria. The enzymes NADH dehydrogenase and succinate dehydrogenase are usually involved in respiration and ATP synthesis. From the results in the table, which of the following statements is most correct?

a. Fraction A corresponds to the cell membrane.

b. Fraction A corresponds to the outer membrane.

c. Fraction B corresponds to the cell membrane.

d. Neither fraction corresponds to the cell membrane.

4. From the results given in the table, which of the following statements is most correct.

a. The cell membrane and the outer membrane have the same composition.

b. The cell membrane and the outer membrane were completely separated in this experiment.

c. The cell membrane and the outer membrane were partially separated in this experiment, but each fraction was contaminated by small amounts of the other.

d. The cell membrane and the outer membrane were not separated in this experiment.

When the phospholipid composition of the membrane fractions was measured, the results in the next table were obtained (each phospholipid is given as the percent of total lipid phosphorus).

phospholipid fraction A fraction B

phosphatidylglycerol 55 86

phosphatidylethanolamine 16 7

phosphatidylcholine 9 7

cardiolipin 15 1

5. The data in the table indicate that:

a. the two membranes are composed only of phospholipids.

b. the cell membrane and outer membrane have the same phospholipid composition.

c. The cell membrane and outer membrane differ in phospholipid composition.

d. The cell membrane is a bilayer but the outer membrane is a monolayer.

Written by:

Charles E. Deutch, Microbion Research

1992

Charles.Deutch@asu.edu