

# Porins



## Introduction

Porins are a class of poreforming proteins in the outer membranes of gram-negative bacteria, mitochondria and chloroplasts.

They show mostly  $\beta$ -barrel structure, have larger pore diameters and are less specific for substrates than ion channels.

Their main task is to mediate the regulated diffusional substrate transport across the outer membrane. Because of the common spread of immunity against antibiotics, porins become more and more important in pharmacology.

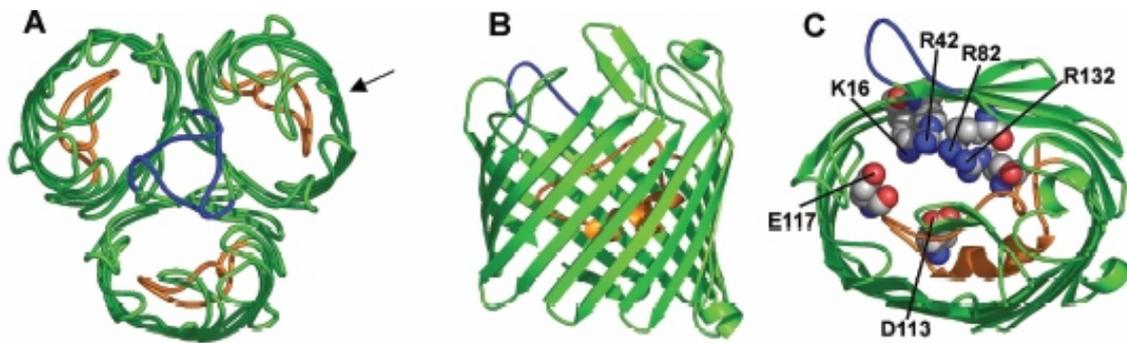


FIG. 2. Structure of the OmpF porin of *E. coli*. A) View of the trimer from the top, in a direction perpendicular to the plane of the membrane. B) View of the monomeric unit from the side, roughly in the direction of the arrow in panel A. C) View of the Monomeric unit from the top, showing the "eyelet" or the constricted region of the channel. Nikaido, H.: Microbiol Mol Biol Rev. 2003 Dec;67(4):593-656

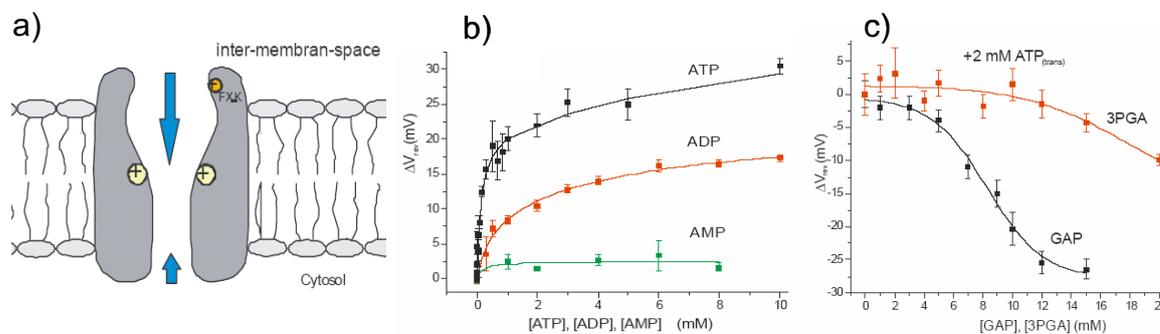
## Features of Porins

Porins ...

- constitute passive diffusion pores
- constitute substrate specific pores
- constitute regulated, specific pores, see example
- change their characteristics in presence of antibiotics
- are part of an effective antibiotic efflux system
- are excreted toxins to invade target cells
- mediate adhesion to target cells
- escape immune pressure by altering their surface structure
- work as nanotubes in material science
- serve as biosensors

## Example: OEP21, an ATP regulated substrate pore in the outer membrane of chloroplasts

Chloroplasts are the photosynthetic organelles in plant cells. According to endosymbiotic theory they once were bacteria that were assimilated by a host cell billions of years ago. Due to that distant relation their outer envelope proteins show specific similarities to bacterial porins. In the past the outer envelope of chloroplasts was believed to be a simple diffusion barrier for small molecules up to 10 kDa with no regulation of transport. The corresponding protein was termed “general diffusion pore”, but its identification on the molecular level is still missing. The investigation of outer membrane vesicles and of a recombinant protein of 21 kDa of the outer membrane with a Ionovation Compact revealed a different picture:



Bilayer experiments with a **Ionovation Compact** device on OEP21 and outer membrane vesicles showed:

- Asymmetrical topology of the channel, with a high accessibility of substrates only from the internal side of the membrane.
- Regulation of the channel properties by sub-millimolar concentrations of ATP and other nucleotides.
- Competition between nucleotides and other phosphorylated metabolic intermediates, tuning the transport properties of the channel to match the needs during photosynthesis and darkness.

This unique bilayer features made this results possible:

- both sides of the pore are easily accessible for substrate exchange
- the porin inserts in a preferred orientation into the bilayer
- only one kind of channel makes single channel analysis easy
- no background currents