

Slide 1

## Bacterial Cell Walls

- Peptidoglycan, cross linked polymer of (GluNAcMurNac)<sub>n</sub> (See Fig. 9.21)
  - Gram-positive: One bilayer and thick peptidoglycan outer shell
  - Gram-negative: Two bilayers with thin peptidoglycan shell in between
    - See Figure 9.23
  - Gram-positive: pentaglycine bridge connects tetrapeptides
  - Gram-negative: direct amide bond between tetrapeptides
- Gram positive bacteria also contain Teichoic Acid, a polymer of glycerol phosphate or ribitol phosphate
  - See Figure 9.25

Slide 2

## Animal Cell Surface Polysaccharides

- Many types of cell-cell interactions are mediated through oligo- and polysaccharides
  - Heart cells beating in synchrony
  - Contact inhibition causing cells in culture to stop growing
  - Leukocytes “rolling” on endothelial cells of vascular walls
  - Association with extracellular matrix of a tissue

Slide 3

## Glycoproteins

*Many structures and functions!*

- May be O-linked or N-linked
- O-linked saccharides are attached to hydroxyl groups of serine, threonine or hydroxylysine
- N-linked saccharides are attached via the amide nitrogens of asparagine residues
  - See structures in Figure 9.26 and 9.29

Slide 4

## O-linked Saccharides of Glycoproteins

- Function in many cases is to adopt an extended conformation
- These extended conformations resemble "bristle brushes"
- Bristle brush structure extends functional domains well above the membrane surface
  - See Figure 9.27

Slide 5

## N-linked Oligosaccharides

*Many functions known or suspected*

- Oligosaccharides can alter the chemical and physical properties of proteins
- Oligosaccharides can stabilize protein conformations and/or protect against proteolysis
- Cleavage of monosaccharide units from N-linked glycoproteins in blood targets them for degradation in the liver - see Figure 9.30

Slide 6

## Proteoglycans

- Glycoproteins whose carbohydrates are mostly glycosaminoglycans
- Found in extracellular matrix
- Variety of functions in binding cells together in tissues, communicating between cells, cushioning in joints, etc.
- Don't worry about details of structure, but recognize names as belonging to this class

Slide 7

# Chapter 10

## Membrane Transport

Slide 8

### Thermodynamics of Transport

- Free Energy change is given by difference in **electrochemical potential** and the quantity transported  
 $\Delta G = n(m_2 - m_1)$   
where  $m$  = the electrochemical potential

Recall from Chapter 3

$$m = m^p + RT \ln C + ZF\Psi$$

where C is the concentration (actually the activity), Z is the charge, F is the Faraday constant (96.5 kJ/volt-mol) and  $\Psi$  is the electrical potential of the solution

We did not discuss the electrical component in Chapter 3. Recall that what we are calling C here is really the activity, i.e. the concentration relative to the standard state. Review your standard state conventions.

Slide 9

### Thermodynamics of Transport, con't.

Therefore the free energy of transport is given by

$$\Delta G = nRT \ln \frac{C_2}{C_1} + nZF\Delta\Psi$$

chemical work    electrical work

See Figures 10.1 and 10.2

Because  $\mu^0$  is the same on both sides of the membrane, this term cancels out. Remember if  $\Delta G$  is negative, the process is spontaneous, and  $\Delta G$  represents the maximum work we can get from the process. If  $\Delta G$  is positive, the process is not spontaneous, and  $\Delta G$  is the minimum work required to realize it. The first term is negative when a substance is moving from a high concentration to a lower concentration ( $C_2 < C_1$ ). The second term is negative when a positive ion (Z is +) moves to a lower potential ( $\Delta\Psi$  is -) or a negative ion (Z is -) moves to a higher potential ( $\Delta\Psi$  is +).

Slide  
10

## Topic Outline

- Passive Diffusion
- Facilitated Diffusion
- Active Transport
  - Driven by ATP hydrolysis (ATPase's)
  - Driven by light
  - Driven by ion gradients
- Group Translocation
- Membrane Pores
- Ionophore Antibiotics

Slide  
11

## Passive Diffusion

- Usually no special protein involved
- Usually substances can dissolve in hydrocarbon layer of membrane
- Transported species moves down electrochemical gradient
- Rate is proportional to concentration of diffusing species

Slide  
12

## Facilitated Diffusion

- Transported species moves down electrochemical gradient
- Usually faster than passive processes
- Membrane protein or other “carrier” involved
- Important distinguishing features:
  - Rate of transport is saturable (See Fig. 10.3)
  - Specificity toward transported species
  - Can have specific inhibitors

Slide  
13

## Examples of Facilitated Diffusion

- Glucose transporter in erythrocytes
  - Example of **uniport**
  - Specific inhibitor, Figure 10.6
  - (See model, Figure 10.5)
- Anion transporter of erythrocytes
  - Example of **antiport**
  - Exchange of  $\text{HCO}_3^-$  and  $\text{Cl}^-$
  - (See model, Figure 10.7)

Slide  
14

## Active Transport, ATP Driven

*Energy of ATP hydrolysis used to do work of transport*

- $\text{Na}^+$ ,  $\text{K}^+$  ATPase
- $\text{Ca}^{2+}$  ATPase
- $\text{H}^+$  ATPases
  - Gastric  $\text{H}^+$ ,  $\text{K}^+$  exchange
  - Cellular vacuoles
  - Osteoclast
  - Mitochondrial and chloroplast ATPase (later chapters)
- MDR ATPase

Slide  
15

## $\text{Na}^+$ , $\text{K}^+$ ATPase

- Pumps  $\text{Na}^+$  out of cells,  $\text{K}^+$  in ( $2\text{K}^+/3\text{Na}^+$ )
- Ion gradients important in nerve transmission, and in “cotransport” of other species
- Two subunits, see Fig 10.9 for membrane model
- Phosphorylation/dephosphorylation and two protein conformations involved
  - See Fig. 10.11 for suggested mechanism
- Specific inhibitor—cardiac glycosides (Fig 10.2)

Inhibitors of the  $\text{Na}^+$ ,  $\text{K}^+$  ATPase can cause high blood pressure!

Slide  
16

## Ca<sup>2+</sup> ATPase

- Ca<sup>2+</sup> is a cellular “second messenger” in virtually all cells
- Normally Ca<sup>2+</sup> is kept low by pumping it into cellular vesicles called the **sarcoplasmic reticulum**
- Pumping is by an ATP driven Ca<sup>2+</sup> ATPase
- Some protein homology to Na<sup>+</sup>, K<sup>+</sup> ATPase
  - (See Fig 10.13)
  - Membrane model (Fig 10.14); mechanism (Fig 10.15)

Slide  
17

## H<sup>+</sup> ATPases

- Gastric H<sup>+</sup>, K<sup>+</sup> ATPase
  - K<sup>+</sup>, Cl<sup>-</sup> **symport** makes it an HCl pump
  - See Figure 10.16
- Vacuoles and Osteoclast
  - See Figure 10.17
- Mitochondrial and Chloroplast ATPases
  - Will discuss later. Role of these pumps is to use proton gradient to drive synthesis of ATP rather than ATP hydrolysis to drive pumping of protons