

# lecture 1

prescotts microbiology 9th edition wm C brown dubuque IA

## microorganisms

- bacteria
- archaea
- viruses
- eukarya (have nucleus)
  - plants, animals
  - fungi - yeasts and moulds
  - protists - protozoa and algae

### *bacteria*

- single celled - reproduce binary fission (splitting into two)
- move using appendages called flagella - rotate
  - no coccus are motile - only rods
- shape: spherical (coccus) rod like (rods) spirals, commas, filamentous
- arrangement based on division
- reproduction: binary fission - most, some reproduce by budding off
- can form chains, clusters pairs
- size: micrometers
  - prokaryotic smaller than eukaryotic
  - E.Coli - rod shaped, 1um wide 3um long
  - usual size range of bacteria = diameter from 0.1um to 50um
- size to shape: larger the size larger surface area therefore more nutrient uptake, also small size to protect from predation
- gram positive - thick peptidoglycan layer (20-80%)
- gram negative - thin peptidoglycan (10-20%) also have LPS layer
- acid fast bacteria - 60% fatty acid layer + mycolic acid

### *microbes and humans*

- resident and normal flora
- pathogens
- useful microorganisms - yeast
- environments
- industrial application
- antibiotics

### *microscopes*

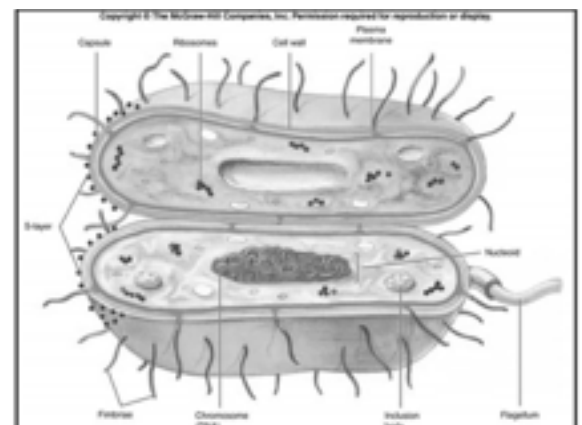
- bacteria observed under 1000x oil immersion
- unstained vs stained - purple = positive, pink = negative

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## lecture 2 - bacteria cell structure and function

### cell structure of bacteria and archaea

- used to be prokaryotes
- 16 S rRNA shows differences in bacteria archaea and eukarya
- common features to both
  - vary shape and size
  - no organised nucleus
  - common cell organisation
- no single organism has all the structures at all time
- same structures in both can differ at molecular level



## cell envelope

- made up of several layers
- inner most: cell membrane - surrounds plasma and content (present in every living cell)
- chemically complex cell wall - covers plasma membrane
- other structures such as capsule or slime layer external to cell wall
  - in archaea capsules are rare - some grow in extreme conditions

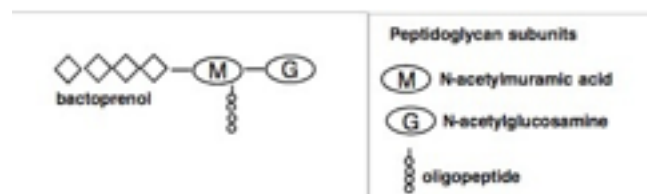
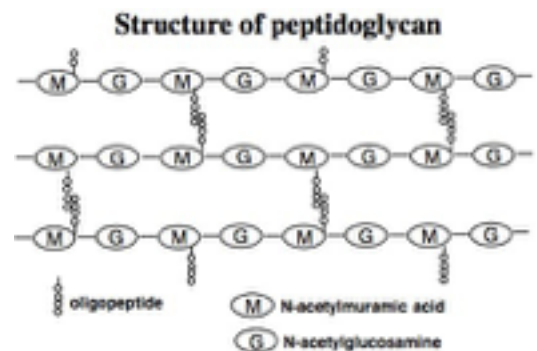
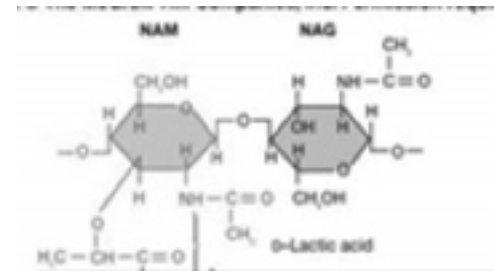
## bacterial structures

- cell wall
- cytoplasmic membrane
- cytoplasmic structures
- outer envelopes
  - capsules
  - slime
  - s-layer
- external structure
  - flagella
  - fimbriae
  - pili - conjugation (genetic modification and transfer of genes)
- bacteria endospores

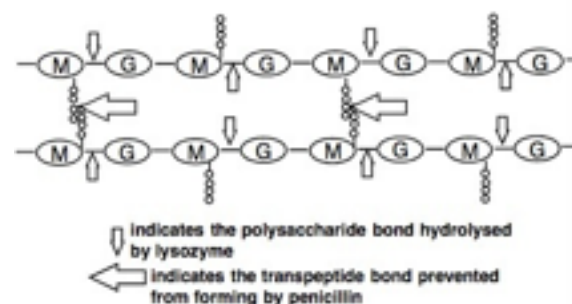
## bacteria cell walls

### functions

- accounts for numb rod bacterial characteristics
- maintains shape
- provides support - preventing collapse or burst
- attachment
- can contribute to pathogenicity
- protect from toxins
- site of action of antibiotics
- gain rigid quality from peptidoglycan
  - mesh like polymer of identical subunits forming long strands
  - chains of glycan
    - two alternating subunits - N-acetyl glucosamine (NAG)
    - N-acetylmuramic acid (NAM)
    - bot similar to glucose
    - covalently linked in long alternating chains
  - cross bridges - peptido
    - four amino acids (tetrapeptides)
    - both D- and L- amino acids (prevents peptidases from destroying cell structure)
  - chains of NAM and NAG connected to other chains by peptido cross bridges (gram negative)
  - depending on type, either covalent bonded or held by chains of amino acids
  - strong and flexible support framework
  - structure:
    - made inside cytoplasm
    - transported across cytoplasmic membrane where added to pre existing peptidoglycan
  - peptidoglycan oligopeptide
    - presence of both types of amino acids (D and L) the peptidoglycan is resistant to peptidases
    - it is susceptible to some enzymes (lysozyme, targets covalent bonding) and antibiotics (penicillin, which targets peptide bonding of gram positive)
    - very useful to drug industry - little protection against lysis
    - natural defence mechanisms such as lysozyme - hydrolyse the bonds in glycan chains cause to break down



### Effects of lysozyme and penicillin

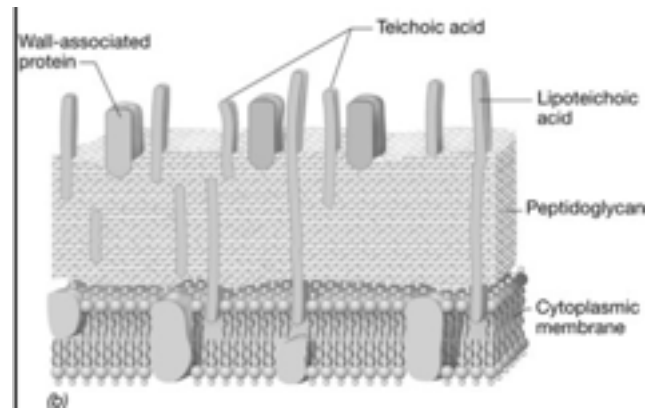


### periplasmic space

- gram pos: gap between plasma membrane and cell wall
- gram neg: between plasma membrane and outer membrane
- periplasm: substance that occupies periplasmic space

### gram pos cell wall

- major portion - thick peptidoglycan layer 20-80nm thick
- contains large amount of secondary cell polymers including
  - *teichoic acid* - polymer of ribitol or glycerol joined by phosphate groups - ONLY IN GRAM POS
    - covalently connected to peptidoglycan or plasma membrane
    - extend to surface or peptidoglycan
    - negatively charged - thus gives the gram pos cell wall its negative charge
    - not found in gram neg
- molecules function in
  - cell envelope creation
  - protect the cell from harm from environment
  - help in binding pathogenic substances to host tissue
  - enlargement during cell division
  - contribute to the acidic (-ve) charge on cell surface



### periplasmic space of gram pos bacteria

- space is smaller than neg - one layer
- few proteins
- those that remain in space bound to plasma membrane
- enzymes secreted by gram pos bacteria = exoenzymes which help to degrade polymeric nutrients (large) and therefore transport of large nutrients across membrane

### gram neg cell wall and outer membrane

- more complex
- single thin peptidoglycan - destroyed quicker
- rigid protective structure
- thinness gives gram neg bacteria greater flexibility, sensitive to lysis
- well developed periplasmic space surrounds peptidoglycan - reaction site for large and varied pool of substances that enter the cell
- complex outer membrane containing (LPS)
  - protein
  - lipoprotein
  - phospholipid
  - lipopolysaccharide
- lipid forms about 15% of outer membrane

### LPS

- polysaccharide chains extending off surface functions as antigens and receptors
- extremely important
- two parts of LPS - lipid A and O-specific polysaccharide side chain (O-antigen)
- importance:
  - protection from host defences (O-antigen)
  - contributes to neg charge on cell surface (core polysaccharide)
  - helps stabilise outer membrane structure (lipid A) to form permeability barrier
  - act as endotoxin (lipid A)

### *Lipid A of LPS*

- liquid portion of LPS is referred to as an endotoxin
  - because toxic activity is an inherent part of cell wall
  - body shows immunogenic response
- toxic reactions
  - chemical make up of lipid A helps body recognise presence of invading bacteria
  - antibodies are produced against LPS
  - these can combine with LPS and neutralise toxicity
  - excess lipid A increases body temp - fever and shock
- gram neg infections such as meningitis and typhoid caused by salmonella typhi

### *O-specific polysaccharide chain*

- made up of chain of sugar molecules
- number and composition varies with bacteria
- characteristic used to identify certain species or strains
- adaptation in gram neg bacteria - rapidly change antigenic nature of o side chains - sidestepping host defences

### **inner most layer of outer membrane**

- phospholipid layer
- anchored to peptidoglycan by lipoproteins
- partial chemical sieve
- only allows small molecules to penetrate
- access through facilitated by special membrane channels formed by porin proteins
- the size of these porin molecules can be altered so as to block harmful chemicals entering
- defence against antibiotics for gram neg

### **gram neg outer membrane permeability**

- more permeable than plasma membrane due to presence of porin proteins and transporter proteins - form channels

### **periplasmic space of gram neg**

- periplasmic space differs from that in gram pos
- 20-40% of cell volume
- many enzymes present in periplasm

### *periplasmic enzymes*

- found in periplasm of gram neg
- functions
  - nutrient acquisition
  - electron transport
  - peptidoglycan synthesis
  - modification of toxic compounds

### **non typical cell wall**

- lack typical gram pos or gram neg
- some have no cell wall
- sometimes can stain either pos or neg

### **acid fast bacterial cell wall**

- bulk of cell wall composed of unique types of lipids
- very long chain of fatty acid
- contributes to pathogenicity of group
- thick waxy nature imparted to cell wall by these lipids
  - hydrophobic
  - makes it impenetrable to most organic molecules including antibiotics
  - high degree of resistance to chemicals and dyes
- basis for acid fast stain
- used in diagnosis of tuberculosis and leprosy
- ziehl neelsen stain or modified kinyoun's stain