CHARACTERISTICS OF PROKARYOTIC AND EUKARYOTIC CELLS

CHAPTER 4

Courtesy of Yves Brun

Detailed studies of cells have revealed that prokaryotes differ enough to be split into two large groups called *domains*. A relatively new concept in classification, domain is the highest taxonomic category, higher even than kingdom. Three domains exist:

- Archaea (archaeobacteria)
- Bacteria (eubacteria)
- Eukarya

Archaea and Bacteria are both prokaryotes. The comparison in the next few slides is between bacteria and Eukaryotic cells. We will deal with archaea in a following slide.

Basic Cell Types:

Prokaryotic are cells that lack a nucleus (nuclear membrane). Prokarotic cells are single cells but are subdivided into Bacteria and Arachaea as mention in the previous slide.

Eukaryotic cells contain a nucleus (nuclear membrane). Eukaryotic cells include: plants, animals, fungi and protists (a very heterogeneous group that are neither animals, plants or fungi and are often single cell and small e.g., protozoa).

Prokaryotes (Bacteria) and Eukaryotes have many similarities and many differences:

Cellular Characteristics

TABLE 4.1 Similarities and Differences Between Prokaryotic and Eukaryotic Cells

Characteristic	Prokaryotic Cells	Eukaryotic Cells
Genetic Structures		
Genetic material (DNA)	Usually found in single circular chromosome	Typically found in paired chromosomes
Location of genetic information	Nuclear region (nucleoid)	Membrane-enclosed nucleus
Nucleolus	Absent	Present
Histones	Absent	Present
Extrachromosomal DNA	In plasmids	In organelles, such as mitochondria and chloroplasts, and in plasmids
Intracellular Structures		
Mitotic spindle	Absent	Present during cell division
Plasma membrane	Fluid-mosaic structure lacking sterols	Fluid-mosaic structure containing sterols
Internal membranes	Only in photosynthetic organisms	Numerous membrane-enclosed organelles
Endoplasmic reticulum	Absent	Present
Respiratory enzymes	Cell membrane	Mitochondria
Chromatophores	Present in photosynthetic bacteria	Absent
Chloroplasts	Absent	Present in some
Golgi apparatus	Absent	Present
Lysosomes	Absent	Present
Peroxisomes	Absent	Present
Ribosomes	70S	80S in cytoplasm and on endoplasmic reticulum, 70S in organelles
Cytoskeleton	Absent	Present

Cellular Characteristics

TABLE 4.1 Similarities and Differences Between Prokaryotic and Eukaryotic Cells

Characteristic	Prokaryotic Cells	Eukaryotic Cells
Extracellular Structures		
Cell wall	Peptidoglycan found on most cells	Cellulose, chitin, or both found on plant and fungal cells
External layer	Capsule or slime layer	Pellicle, test, or shell in certain protists
Flagella	When present, consist of fibrils of flagellin	When present, consist of complex membrane-enclosed structure with "9 + 2" microtubule arrangement
Cilia	Absent	Present as structures shorter than, but similar to, flagella in some eukaryotic cells
Pili	Present as attachment or conjugation pili in some prokaryotic cells	Absent
Reproductive Process		
Cell division	Binary fission	Mitosis and/or meiosis
Sexual exchange of genetic material	Not part of reproduction	Meiosis
Sexual or asexual reproduction	Only asexual reproduction	Sexual or asexual reproduction

Size: Most prokaryotes range from 0.5 to 2.0 µm in diameter. A human red blood cell is about 7.5 µm.

Shape

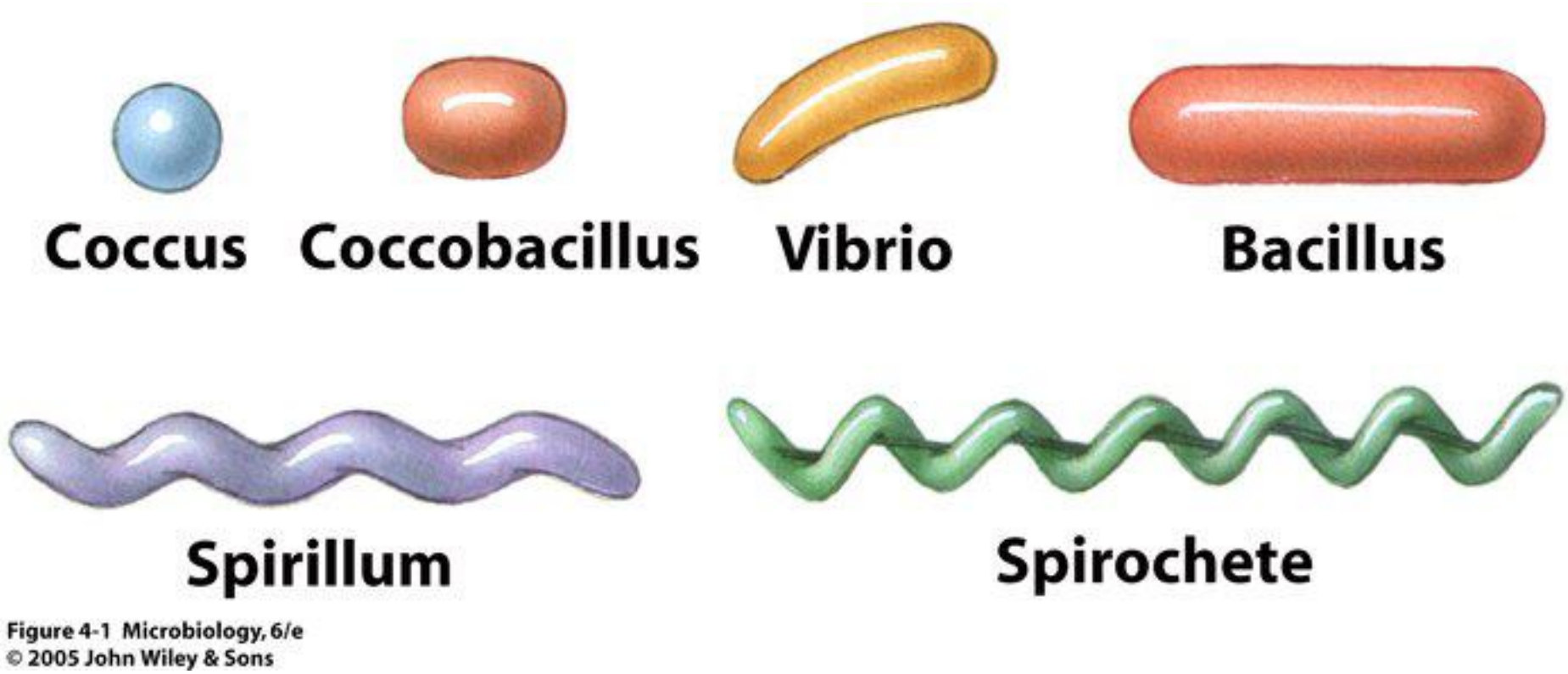
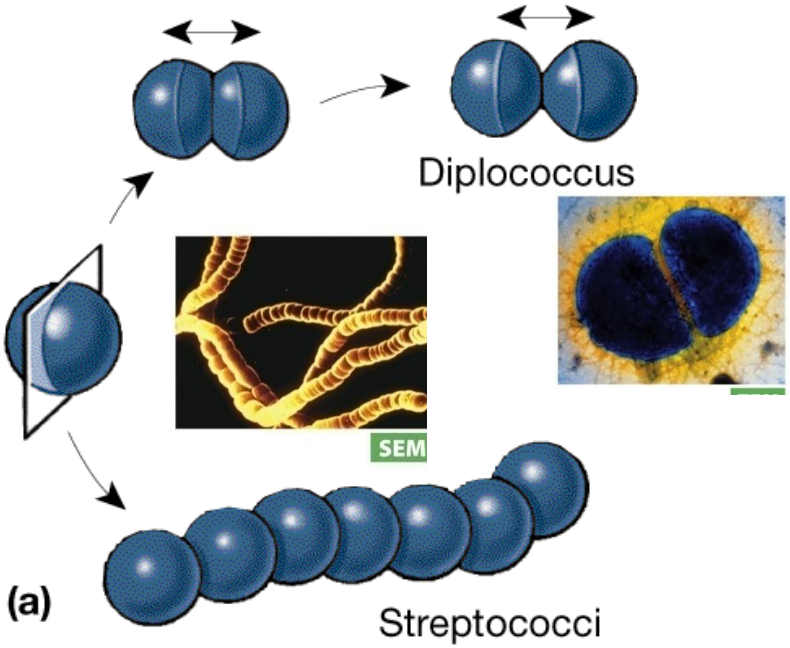
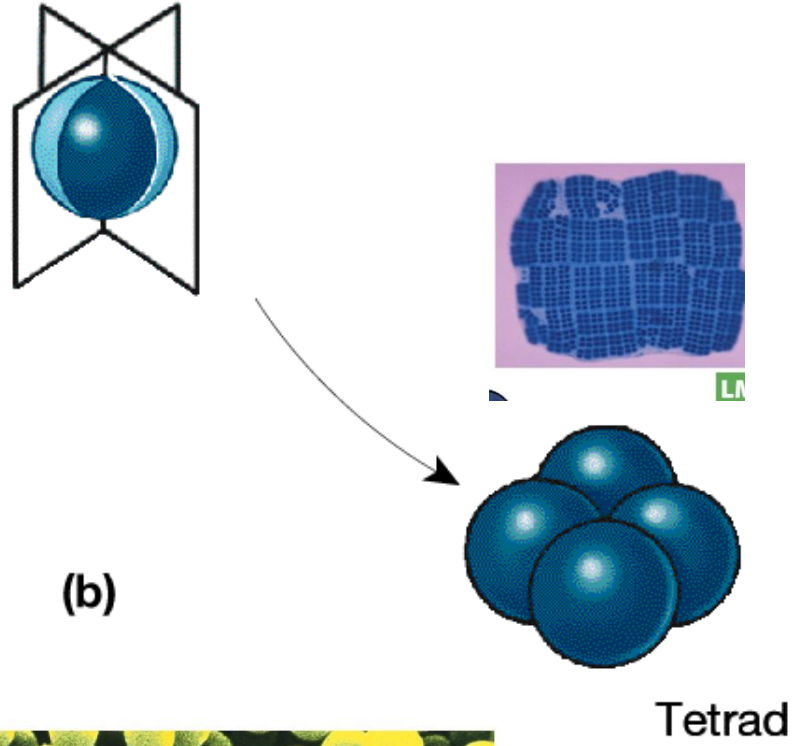


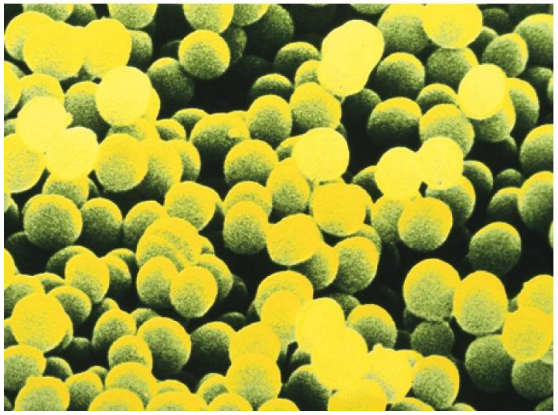
Figure 4-1 Microbiology, 6/e

Bacteria which show a wide variety of shapes within a single species are said to be **Pleomorphic.** Those of you taking the laboratory will see the various shapes of bacteria first-hand.

Fig. 4.1 **The most common bacterial shapes**







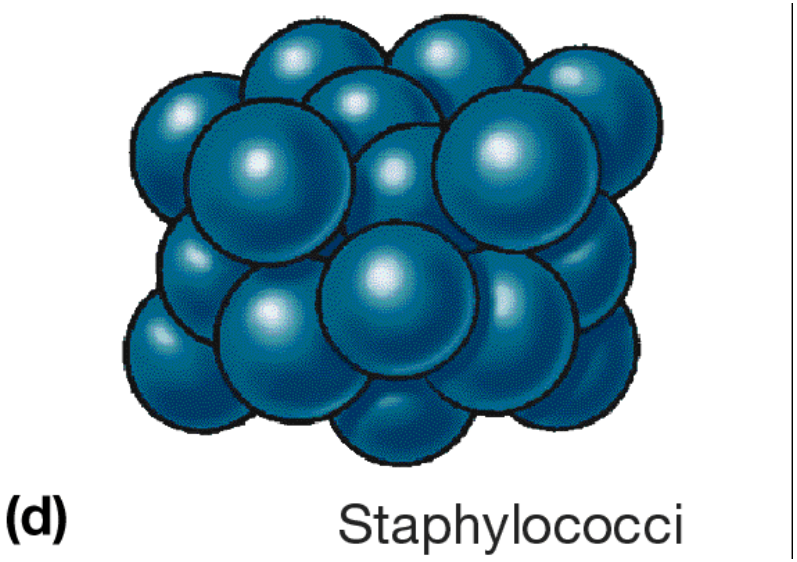
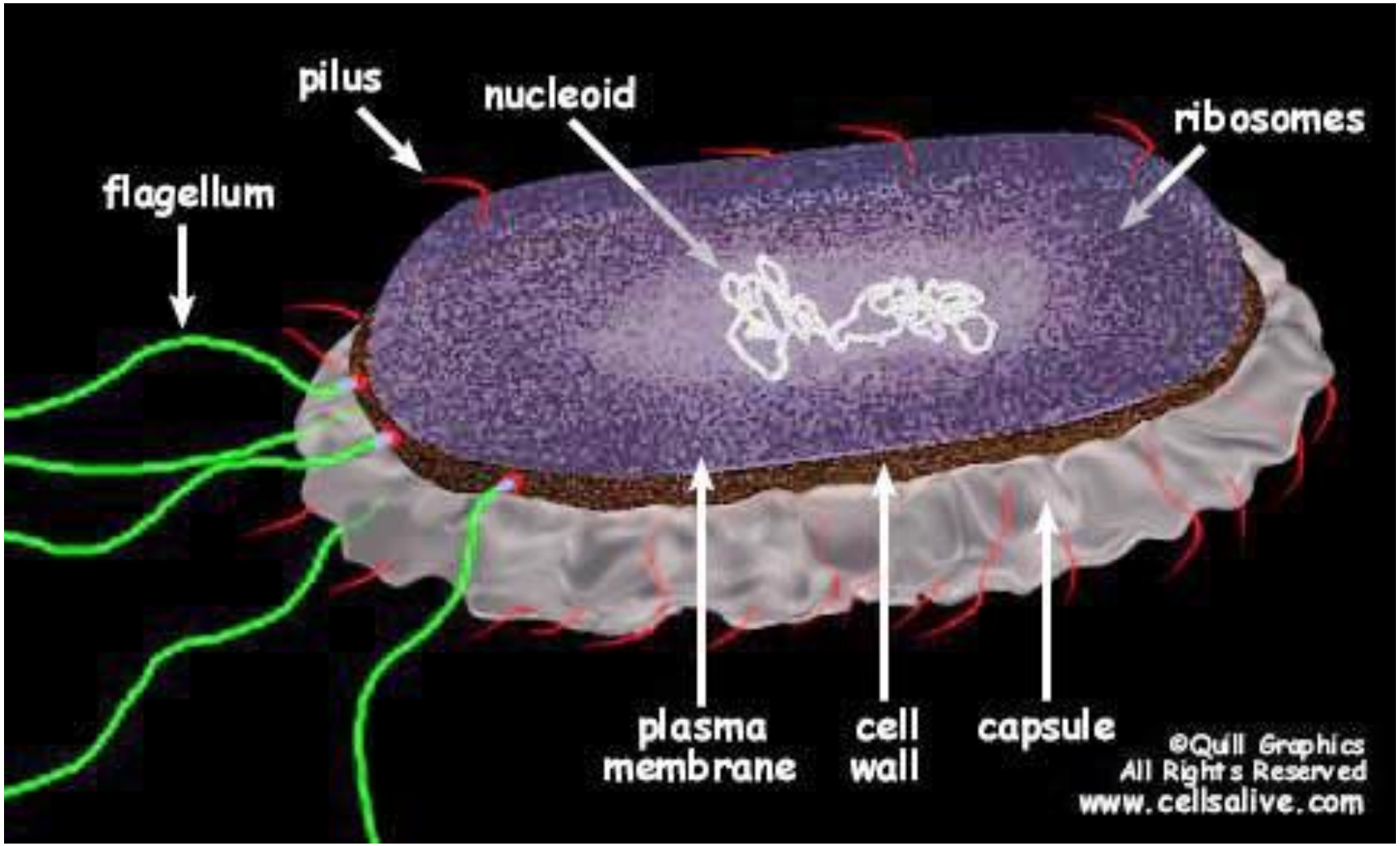


Fig. 4.2 **Arrangements of some of The more common cocci forms of bacteria**

An overview of structure



1. Cell membrane-typically surrounded by a cell wall
2. Internal cytoplasm with ribosomes, a nuclear region and granules
3. Lots of external structure, e.g., capsules, flagella and pili

Fig. 4.3 **A typical prokaryotic cell**

http://www.youtube.com/watch?v=9JVyIjpUybs&feature=relmfu

Gram stain

http://www.youtube.com/watch?v=Oc6bo2fo0ag&playnext=1&list=PL08D2F3AB65E39C37

Capsule stain

http://www.youtube.com/watch?v=a9HF4aM5QHk&feature=relmfu

Endospore stain

http://www.youtube.com/watch?v=qmHvblk0kZo&feature=relmfu

Acid fast stain

For those of you not in the laboratory these videos will show you how the stains are done and how stained cells appear.

http://www.youtube.com/watch?v=Dv6J-8Vi2t4

Pili and bacterial attachment

View on your own

The Cell Wall

The semi-rigid cell wall lies outside the cell membrane in nearly all bacteria (***Mycoplasma* being an exception**).

A. maintains cell shape

B. acts as a corset in preventing cells from bursting in hypotonic solution (**you can store a culture of *E. coli* in distilled water for weeks to months**)

C. it is quite porous and has little effect on the inflow and outflow of materials

Peptidoglycan- the structure that gives shape and strength to bacteria. Many bacteria can be stored in distilled water because that have a peptidoglycan "corset". Gram positive and Gram negative organisms have somewhat different peptidoglycan layers as we will see on the next slide. The peptidoglycan layer permits bacteria, e.g., *E. coli* to be stored in hypotonic solutions, e.g., distilled water, for weeks.

Chickenpox Down 80 Percent Since 2000 Signaling the retreat of a childhood rite of passage, the incidence of chickenpox in the United States fell by 80 percent from 2000 to 2010, the Centers for Disease Control and Prevention reported last week.

The decline results from widespread use of the chickenpox vaccine, researchers said.

From 2000 to 2005, a period when a single dose of vaccine was recommended for children 12 to 18 months old and for older unvaccinated children, cases fell by 43 percent. The decline steepened once a second dose was recommended in 2006, with incidence falling 72 percent in the second half of the decade.

Chickenpox cases decreased most in children ages 1 through 9, who were most likely to get the vaccine, according to the C.D.C. After 2006, chickenpox decreased especially prominently in children ages 5 through 9, the group most likely to have gotten a second dose during that period.

The C.D.C. previously reported significant decreases in chickenpox from 1995 to 2000, with incidence falling by 70 to 85 percent in three communities selected for surveillance.

Adriana Lopez, a C.D.C. epidemiologist and a contributor to the report, said she was encouraged that chickenpox, also called varicella, continues to decline.

"Based on this study, we've seen that the varicella vaccination program, including the second dose, is working to decrease disease," she said.

An Immune Disorder at the Root of Autism in recent years, scientists have made extraordinary advances in understanding the causes of autism, now estimated to afflict 1 in 88 children. But remarkably little of this understanding has percolated into popular awareness, which often remains fixated on vaccines. So here's the short of it: At least a subset of autism — perhaps one-third, and very likely more — looks like a type of inflammatory disease. And it begins in the womb. It starts with what scientists call immune dysregulation. Ideally, your immune system should operate like an enlightened action hero, meting out inflammation precisely, accurately and with deadly force when necessary, but then quickly returning to a Zen-like calm. Doing so requires an optimal balance of pro- and anti-inflammatory muscle. In autistic individuals, the immune system fails at this balancing act. Inflammatory signals dominate. Anti-inflammatory ones are inadequate. A state of chronic activation prevails. And the more skewed toward inflammation, the more acute the autistic symptoms. **A population-wide study from Denmark spanning two decades of births indicates that infection during pregnancy increases the risk of autism in the child. Hospitalization for a viral infection, like the flu, during the first trimester of pregnancy triples the odds. Bacterial infection, including of the urinary tract, during the second trimester increases chances by 40 percent.The lesson here isn't necessarily that viruses and bacteria directly damage the fetus. Rather, the mother's attempt to repel invaders — her inflammatory response — seems at fault. Generally, the scientists working on autism and inflammation aren't aware of this — or if they are, they don't let on. But Kevin Becker, a geneticist at the National Institutes of Health, has pointed out that asthma and autism follow similar epidemiological patterns. They're both more common in urban areas than rural; firstborns seem to be at greater risk; they disproportionately afflict young boys.**

In the context of allergic disease, the hygiene hypothesis — that we suffer from microbial deprivation — has long been invoked to explain these patterns. Dr. Becker argues that it should apply to autism as well. (Why the male bias? Male fetuses, it turns out, are more sensitive to Mom's inflammation than females.) Future doctors will need to correct the postmodern tendency toward immune dysregulation. Evolution has provided us with a road map: the original accretion pattern of the superorganism. Preventive medicine will need, by strange necessity, to emulate the patterns from deep in our past.

Alarming levels of drug-resistant TB found worldwide LONDON (Reuters) - Scientists have found an alarming number of cases of the lung disease tuberculosis in Africa, Asia, Europe and Latin America that are resistant to up to four powerful antibiotic drugs. In a large international study published in the Lancet medical journal on Thursday, researchers found rates of both multi drug-resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) were higher than previously thought and were threatening global efforts to curb the spread of the disease. Most international recommendations for TB control have been developed for MDR-TB prevalence of up to around 5 percent. Yet now we face prevalence up to 10 times higher in some places, where almost half of the patients ... are transmitting MDR strains," Sven Hoffner of the Swedish Institute for Communicable Disease Control, said in a commentary on the study. **TB is already a worldwide pandemic that infected 8.8 million people and killed 1.4 million in 2010.** Drug-resistant TB is more difficult and costly than normal TB to treat, and is more often fatal. MDR-TB is resistant to at least two first-line drugs — isoniazid and rifampicin - while XDR-TB is resistant to those two drugs as well as a powerful antibiotic type called a fluoroquinolone and a second-line injectable antibiotic. Treating even normal TB is a long process, with patients needing to take a cocktail of powerful antibiotics for six months. Many patients fail to complete their treatment correctly, a factor which has fuelled a rise in the drug-resistant forms. **TB is a bacterial infection that destroys patients' lung tissue, making them cough and sneeze and spread germs through the air. Experts say anyone with active TB can easily infect another 10 to 15 people a year. The World Health Organization (WHO) predicts more than 2 million people will contract MDR TB by 2015.**

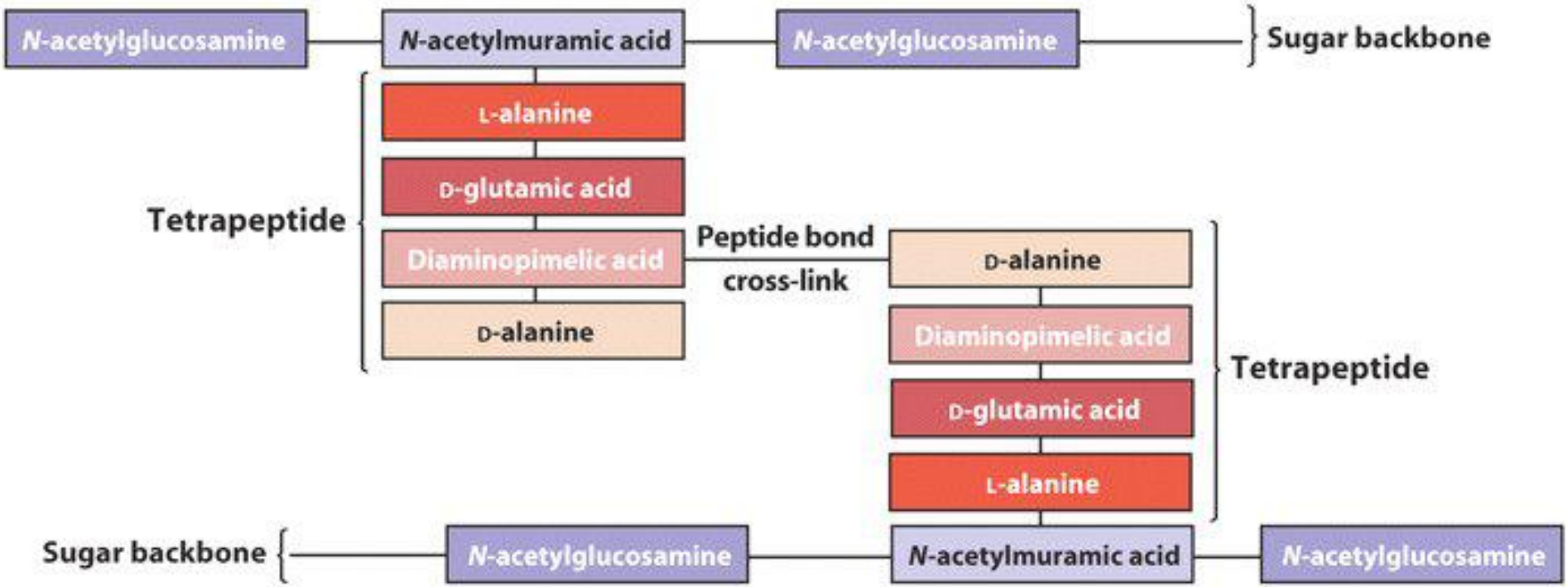


Figure 4-4a Microbiology, 6/e

Gram negative peptidoglycan (*E. coli)* which is basically a two-dimensional structure because it lacks the pentaglycine cross-linker of Gm + orgs.

Fig. 4.4 A-**two dimensional view of Gram negative wall,**

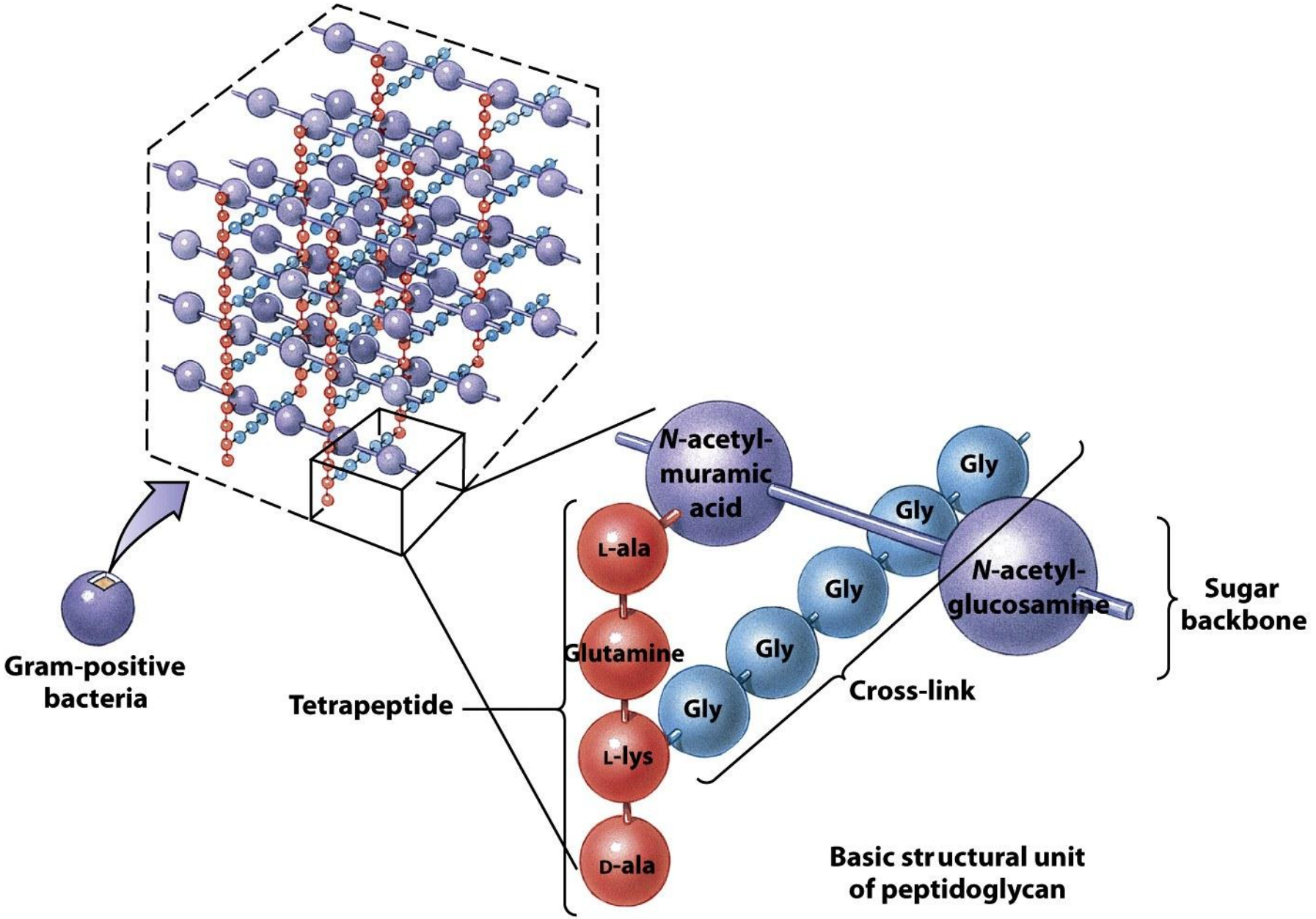


Figure 4-4b Microbiology, 7/e

Fig. 4.4B- A three-dimensional view of peptidoglycan for Gram positive bacteria

http://student.ccbcmd.edu/courses/bio141/lecguide/unit1/prostruct/ppg_synth/ppgsynth_fl.html

http://www.youtube.com/watch?v=g8A3ZlPffuo

Synthesis of peptidoglycan

Although we will deal with antibiotics that block cell wall synthesis in another chapter- having seen how the cell wall is synthesized how penicillin block cell wall synthesis would be in order (even though we will see it again in the antibiotic chapter).

How penicillin inhibits cell wall synthesis

http://student.ccbcmd.edu/courses/bio141/lecguide/unit1/prostruct/penres_fl.html

http://usf.usfca.edu/fac_staff/jspencer/flash/spencer_cellwall.swf

Periplasmic space - A gap between the cell wall and the cytoplasmic membrane most easily observed in Gram negative organisms since they have a double membrane and is not characteristically considered a feature of gram positive organisms although some refer to the space between inner and outer leflets of the plasma membrane of Gram positive organisms as a periplasmic space (I do not). It is a region of high enzymatic activity containing many digestive enzymes and transport proteins. It is also a region that is outside of the normal array of digestive enzymes associated with the cytoplasm (in particular certain proteolytic enzymes). We will see it in fig. 4.6b

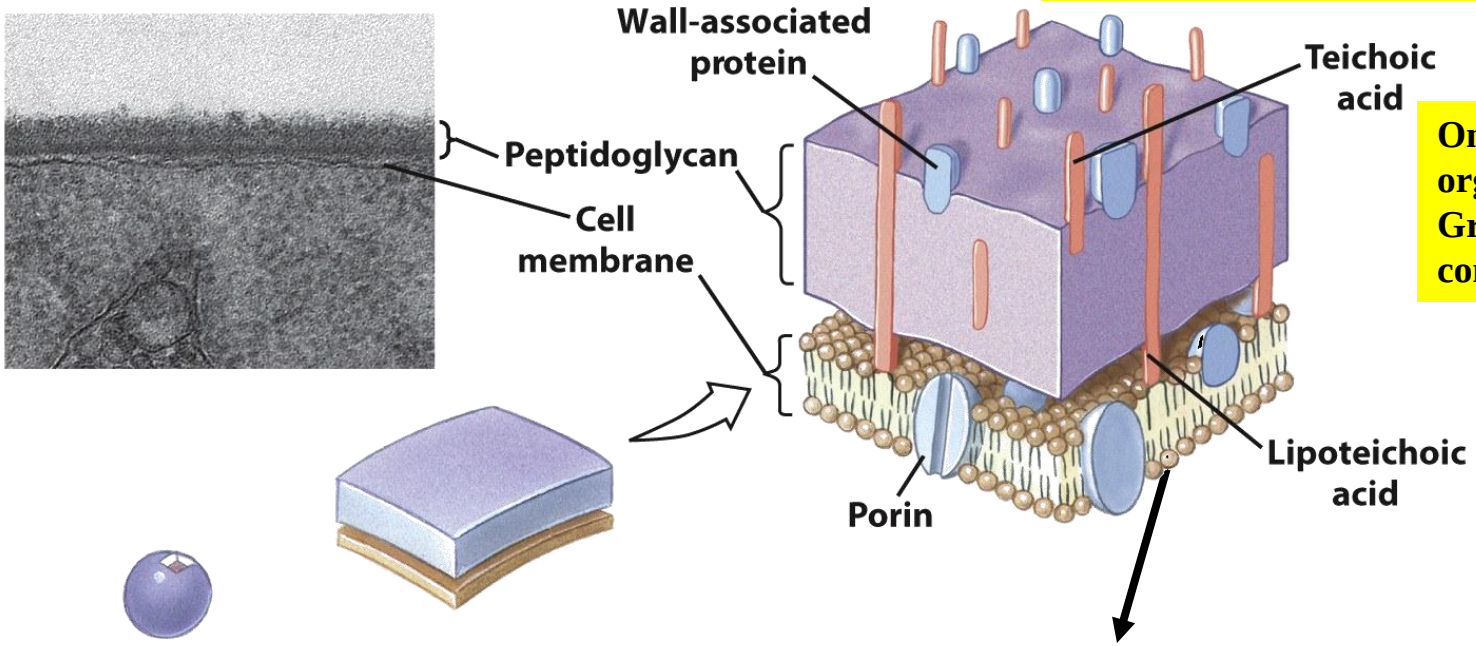
Distinguishing Bacteria by Cell Walls- Gram negative and Gram positive

http://www.youtube.com/watch?v=QEc2aUaD25w

Peptidoglycan layer Gm + and Gm -

Fig. 4.6a **Gram positive cell wall**

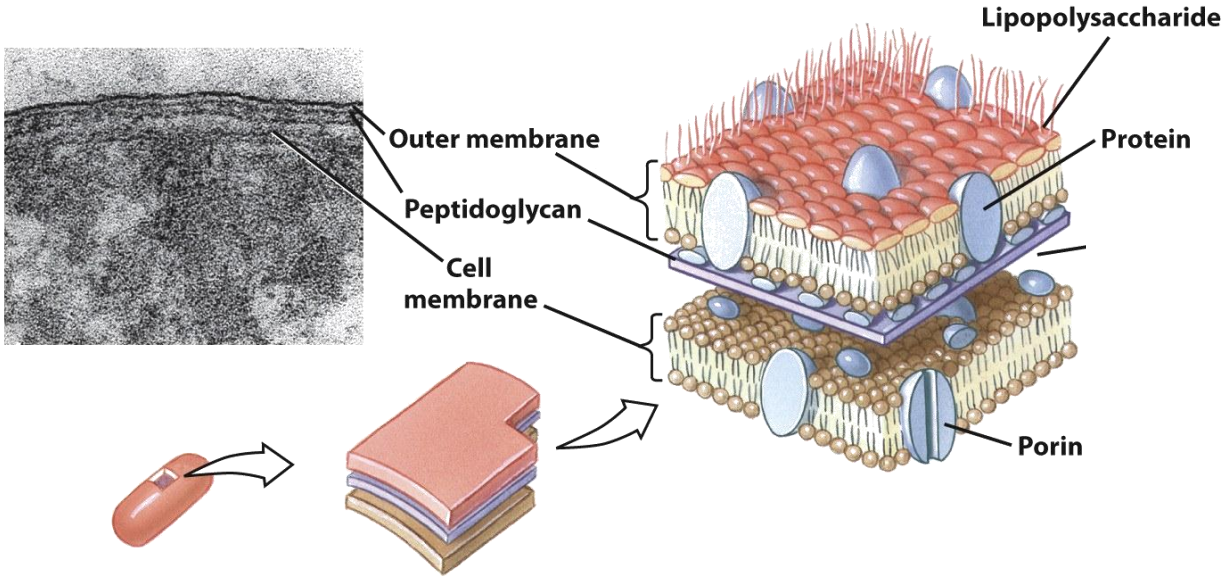
* Teichoic acid a polymer of glycerol, phosphate and ribitol occurs in units up to 30 units long extends beyond the cell wall



Only found in Gm + organisms, but not all Gram + organism contain teichoic acid.

Gram Negative Cell Walls

- Outer Membrane
- Periplasmic space
  - Digestive Enzymes
  - Protein pumps
- LPS components



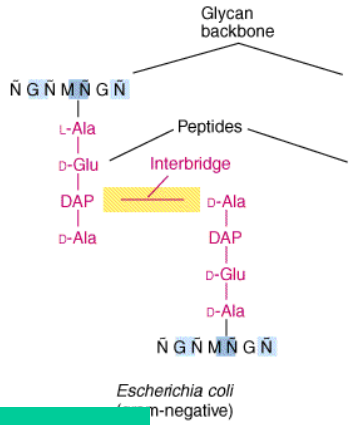
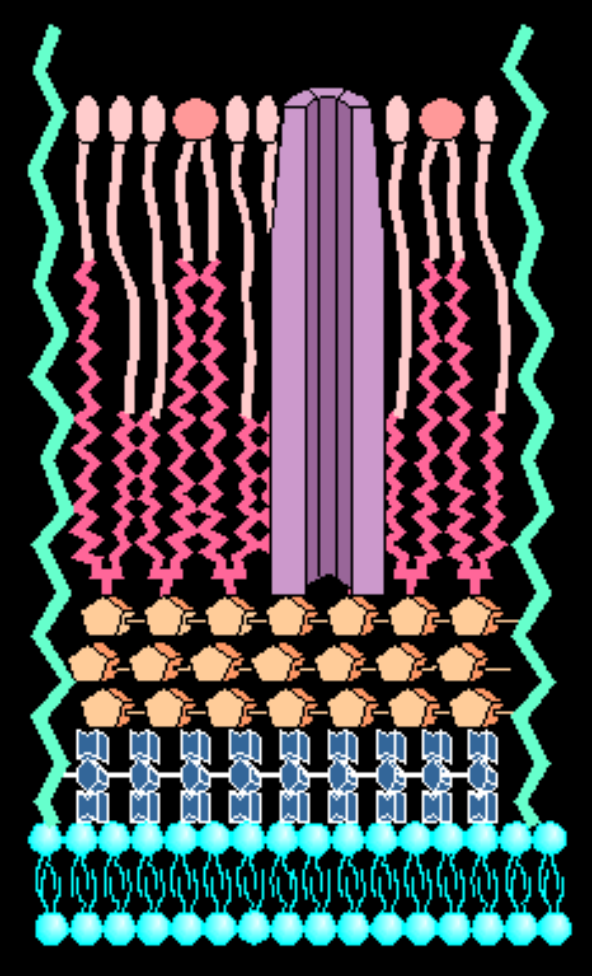


Fig. 4.6b **Gram negative cell wall**

Acid Fast Cell Wall



Acyl lipids

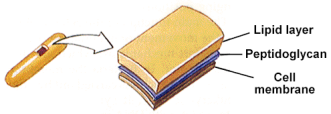
lipoarabinomannan (LAM)

Mycolic acid

arabinogalactan

peptidoglycan

Lipid bilayer



The complex structure of the acid fast cell wall makes it a good barrier against many physical agents, such as phagocytic cell digestion, penetration by antibacterial agents.

lipoarabinomannan (LAM) is a glycolipid, and a virulence factor associated with *Mycobacterium tuberculosis*, the bacteria responsible for tuberculosis. Its primary function is to inactivate macrophages and scavenge oxidative radicals. Mycolic acid is also associated with the virulence of *M. tuberculosis*.

Mycobacterium tuberculosis (TB organism is an acid fast organism)

Fig. **4.6c-Acid fast cell wall**

TABLE 4.2

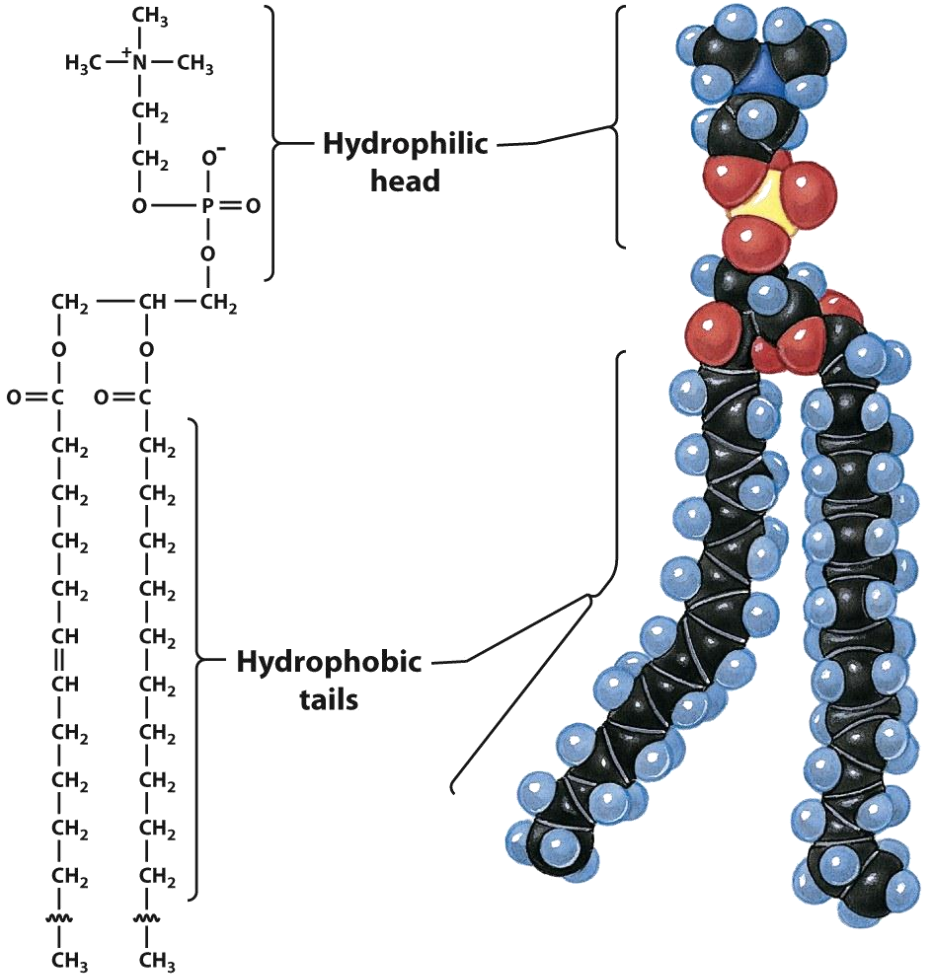
Characteristics of the Cell Walls of Gram-Positive, Gram-Negative, and Acid-Fast Bacteria

Characteristic	Gram-Positive Bacteria	Gram-Negative Bacteria	Acid-Fast Bacteria
Peptidoglycan	Thick layer	Thin layer	Relatively small amount
Teichoic acid	Often present	Absent	Absent
Lipids	Very little present	Lipopolysaccharide	Mycolic acid and other waxes and glycolipids
Outer membrane	Absent	Present	Absent
Periplasmic space	Absent	Present	Absent
Cell shape	Always rigid	Rigid or flexible	Rigid or flexible
Results of enzyme digestion	Protoplast	Spheroplast	Difficult to digest
Sensitivity to dyes and antibiotics	Most sensitive	Moderately sensitive	Least sensitive

Table 4-2 Microbiology, 6/e

Prokaryotic Plasma Membrane

- Phospholipids
- Fluid Mosaic



6 dead in Quebec Legionnaire's disease outbreak Legionnaire's disease, which hit Quebec in mid-July, has infected 65 people and killed six, health authorities of the French-speaking Canadian province said. "We are very concerned by the current situation," Quebec public health chief Francois Desbiens said.

"It's the largest legionellosis outbreak in Canada in recent years."

Sixteen new cases were reported on Thursday alone.

Health authorities suspect improper maintenance of cooling towers in air conditioning systems are at fault for the outbreak.

Legionella bacteria grow in stagnant water in such appliances, then spread with droplets expelled by the system during operation.

The 68 cooling towers housed in 28 buildings were inspected, cleaned and disinfected, but the operation has not put an end to the epidemic.

The disease, which poses a risk for people with weak immune systems, can be treated with antibiotics.

Legionnaire's disease -- discovered in 1976 during a veterans convention in the United States, where 29 people died -- is an infection that causes high fever, dry cough and pneumonia.

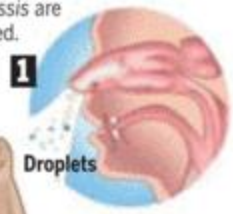
Novel Stem Cell Treatment May Hold Promise for Type 1 Diabetes) -- A new type of stem cell treatment for people with type 1 diabetes appears to help re-educate rogue immune system cells, which allows cells in the pancreas to start producing insulin again. **The treatment, which combines a patient's immune system cells with stem cells from a donor's cord blood, even worked in people with long-standing diabetes who were believed to have no insulin-producing ability.** Although the treatment didn't wean anyone off insulin completely, average blood sugar levels dropped significantly, which would reduce the risk of long-term complications. "Our study brings a new hope for people with type 1 diabetes. If we can control the autoimmunity, we may reverse the diabetes. We showed that the islets [cells] can start to work again," said Dr. Yong Zhao, an assistant professor in the section of endocrinology, diabetes and metabolism at the University of Illinois at Chicago. The study participants, who were 15 to 41 years old, had had type 1 diabetes for an average of nine years. Six had some residual beta cell function and six did not. Both groups were given stem cell educator therapy. The other three people served as the control group. The researchers measured C-peptide, a protein fragment that's a byproduct of insulin production, and found that the educator therapy group had improved levels of C-peptide at 12 weeks. These levels continued to improve until 24 weeks, and remained stable through the follow-up at 40 weeks. There were no changes in C-peptide in the control group. The average daily dose of insulin dropped almost 39 percent after 12 weeks for the group with some beta cell function and 25 percent in those with no beta cell function**, suggesting that the group with no beta cell function now produced insulin**. That means if you stop the autoimmune reaction, you may see beta cell regeneration, or there might be other precursor cells in the pancreas. If these data are confirmed, this is a very provocative and remarkable finding," Inverardi said. The average hemoglobin A1C level dropped 1.06 percent for those with residual beta cell function and 1.68 percent for those without beta cell function. A1C levels measure average blood sugar levels over two to three months, and people with type 1 diabetes are advised to maintain A1C levels below 7 percent. **A drop of 1 percent in A1C levels** can reduce the risk of complications. This was an initial clinical trial designed to test for safety. Zhao said that in future trials he hopes that with additional treatments people might get off insulin altogether.

Increase in whooping cough cases concerns Kentucky health officialsState health officials are encouraging parents to be wary of the looming threat of whooping cough in Kentucky. Whooping cough is spread by miniscule droplets that carry the disease, so "we want people to be aware and do the preventive kinds of things," said Lois Davis, public health nursing manager for the Lexington-Fayette County Health Department. Preventive measures would include making sure that children are current on their vaccines, including getting a booster shot before entering sixth grade and that adults who work with children have been vaccinated. Basic hygiene, such as washing your hands or using anti- bacterial gel, also is important. here have been several outbreaks of whooping cough, also called pertussis, across the country this year. According to the Centers for Disease Control and Prevention, there were nearly 4,000 cases reported in Washington state, up from 363 in 2011. The CDC also reports substantial outbreaks in Wisconsin and Minnesota. **There have been a higher-than-normal 359 cases in Kentucky this year, said Beth Fisher, a spokeswoman for the state Cabinet for Health and Family Services. This summer there were 20 confirmed cases in Estill County, which caused the local health department to offer special vaccination clinics, she said.** Three Rivers District Health Department in Owenton, which serves Owen, Carroll, Gallatin and Pendleton counties, will offer shots at fall festivals in the district to stave off the spread of the disease. **The Fayette County health department isn't planning special clinics at this time, so people who are worried about the illness should contact their family physicians, said Davis Some pharmacies, such as Walgreens, are offering the shots in their stores.**

Developing the disease

Doctors call the disease pertussis, after the bacterium *Bordetella pertussis*, which causes a severe infection with symptoms that can last for weeks. Here's a look at how an infection develops:

Microscopic droplets carrying *Bordetella pertussis* are inhaled.



Bacteria hook to cells lining the throat whose hairlike "cilia" sweep away foreign objects.

Bacteria reproduce and migrate toward ciliated cells of the lungs.

Bacteria release a toxin that paralyzes the cilia and kills cells.

Toxin released in the lungs spreads throughout the body.

Pneumonia might develop if tiny air sacs deep in lungs become infected.

Source: Pediatric Infectious Disease Journal, University of Virginia Health Sciences Center

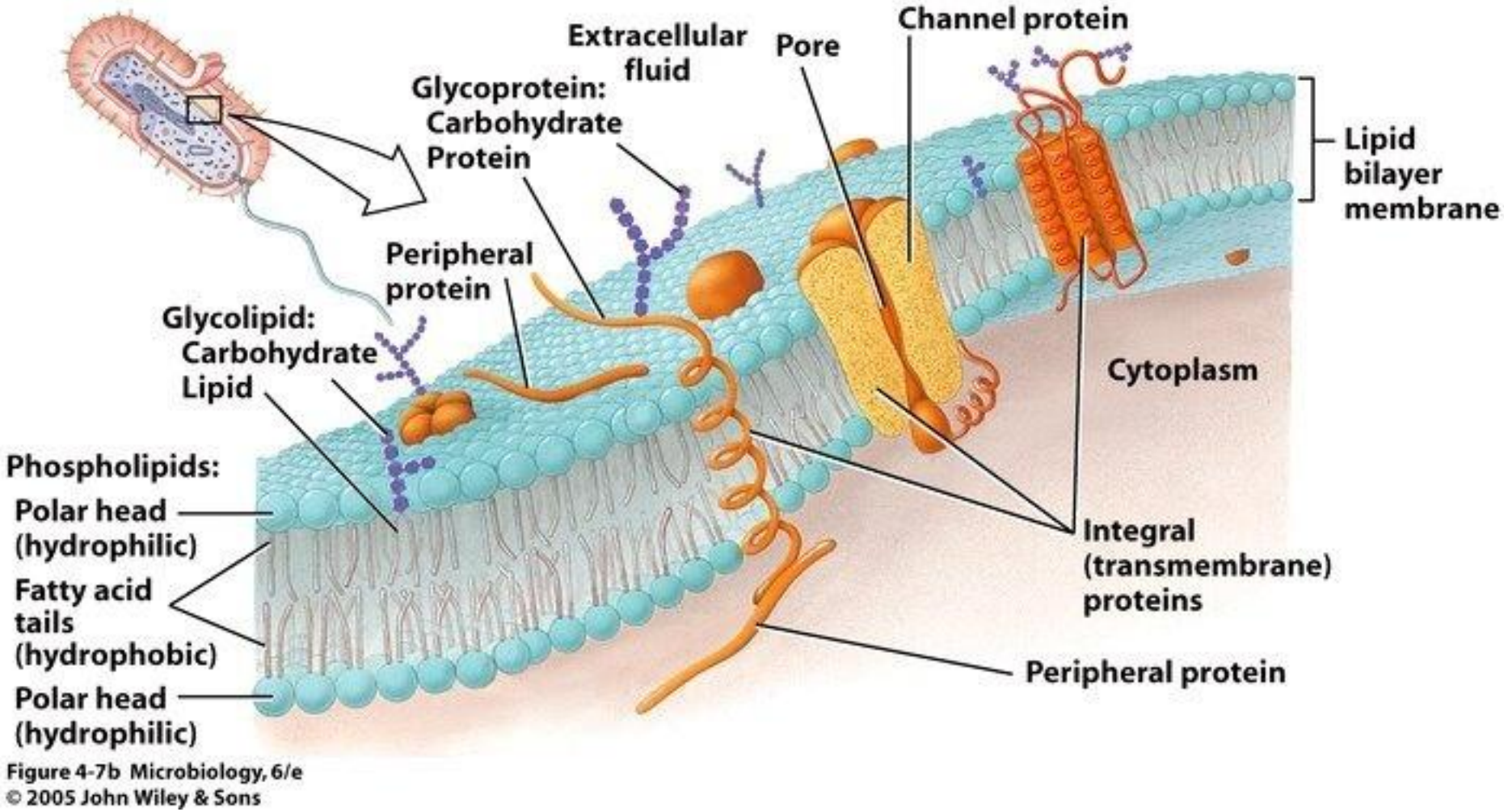


Figure 4-7b Microbiology, 6/e

Several reasons why this generic structure looks more like a eukaryotic plasma membane than a prokaryotic one

Fig. 4.7 **The fluid-mosaic model of the cell membrane-**

The Cytoplasm-semi-fluid substance inside the cell membrane.

Cytoplasm is about four-fifths water and one-fifth substances dissolved or suspended in the water (enzymes, carbohydrates, lipids, inorganic ions as well as containing ribosomes and chromosomes.

Ribosomes- consist of ribonucleic acid and protein.

Contain two subunits a **large (50S)** and a **small (30S). What does S stand for?** The intact ribosome with both subunits is a **70S particle**. The relative size is determined by measuring their sedimentation rates-the rates at which they move toward the bottom of a tube, containing a concentration gradient of a viscous substance like sucrose, when the tube is rapidly spun**.** Certain antibiotics such as **streptomycin and erythromycin bind to the 70S ribosome; and disrupt protein synthesis. Because those antibiotics largely do not affect the 80S ribosomes found in eukaryotic cells, they kill bacteria without harming host cells- at therapeutic concentrations.**

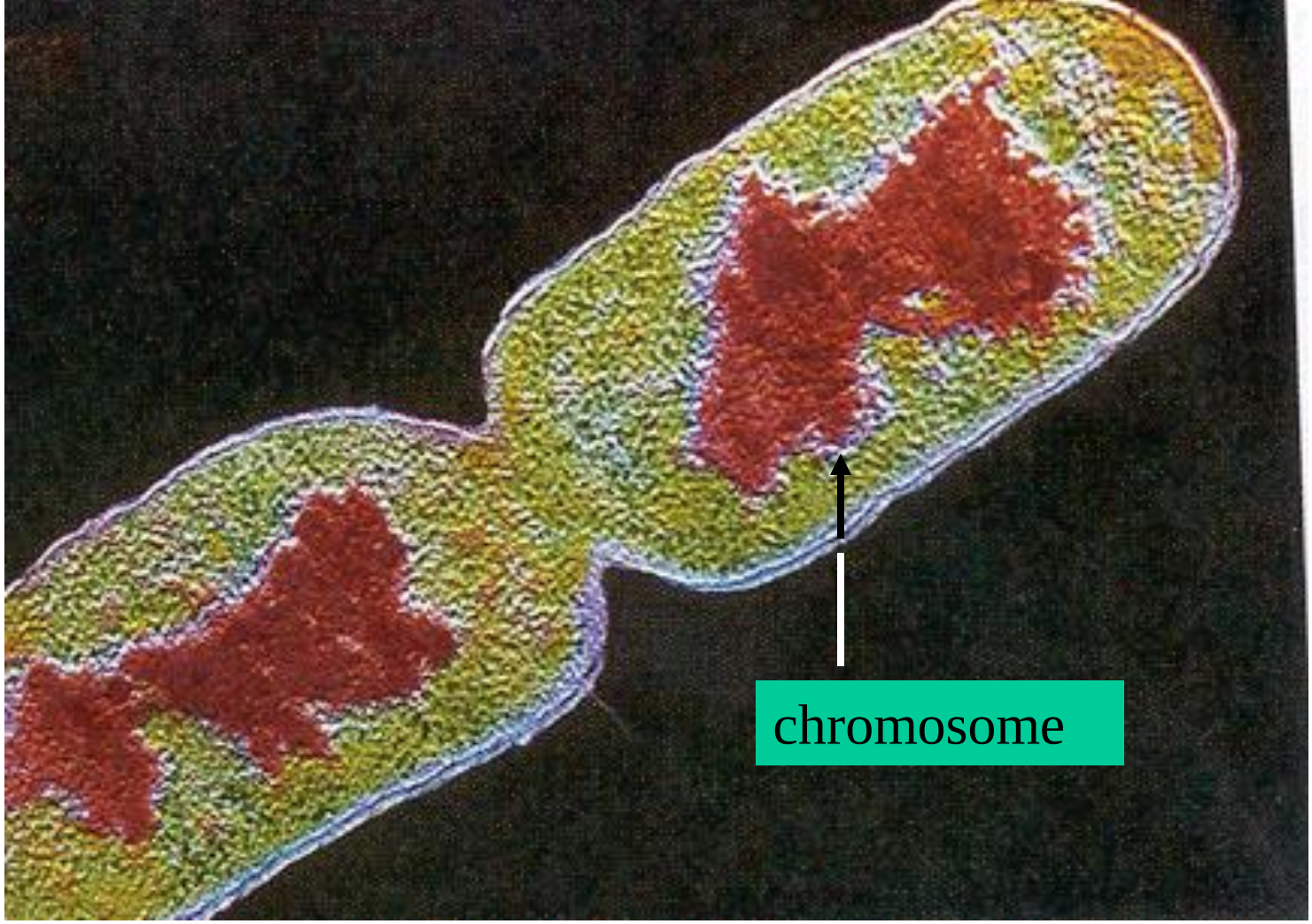


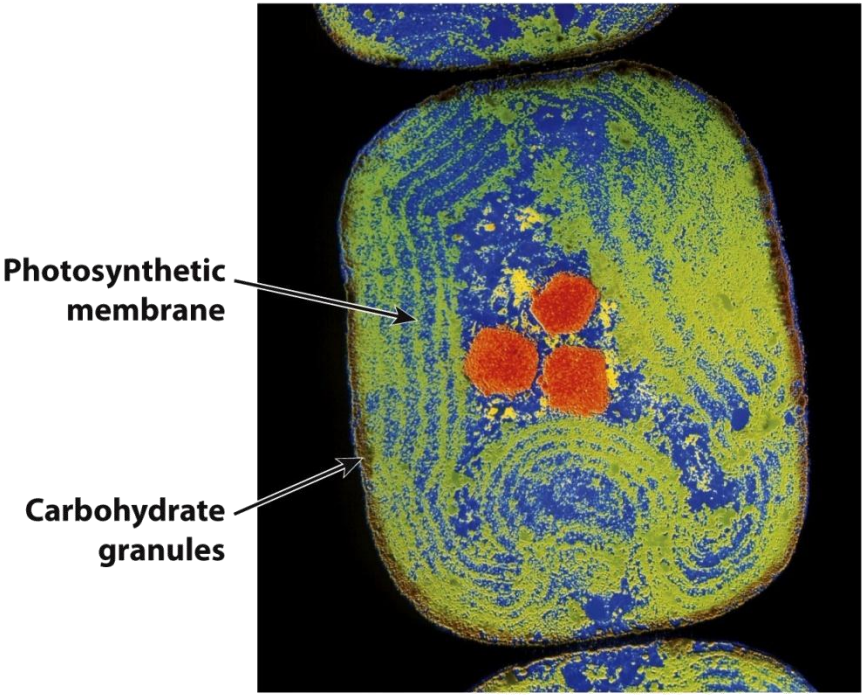
Fig. 4.9 **The bacterial nuclear region**

Internal membranes: Bacteria do not contain free-standing organelles but some (photosynthetic bacteria and nitrifying bacteria contain extensive membrane systems derived from the plasma membrane which contain enzymes for photosynthesis or for the oxidation of nitrogen containing compounds. These membranes are invaginations of the plasma membrane and are not free standing membranes.

Fig. 4.10 Internal membrane system

Inclusions

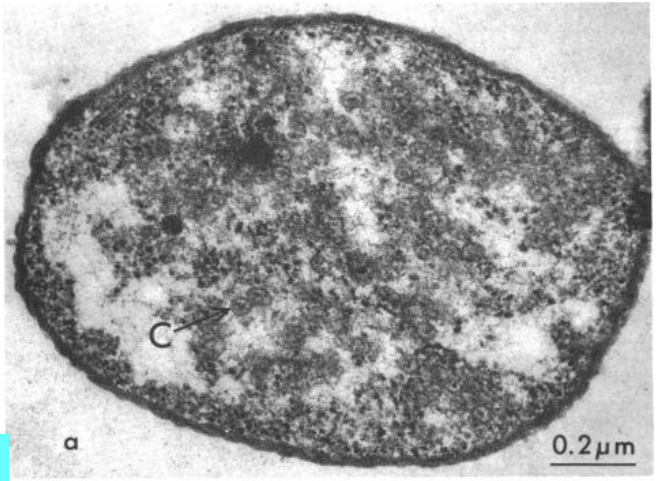
- Chromatophores
- Metachromatic granules
- Vesicles



Dr. Kari Lounatmaa/Photo Researchers, Inc.

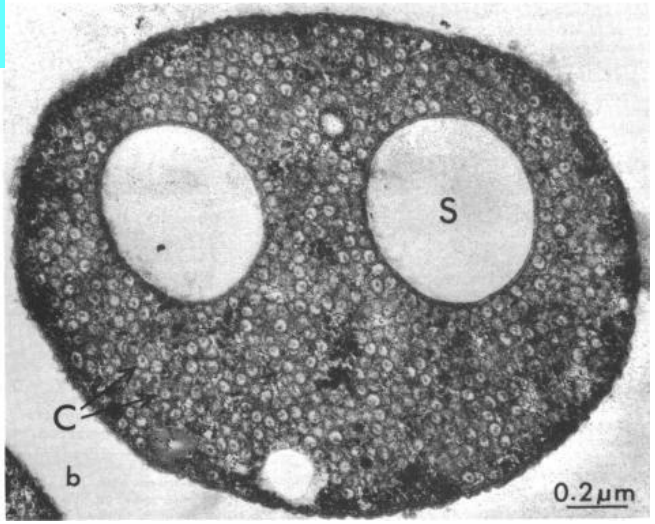
Polar Lipids of *Chromatium* Strain D Grown at Different Light Intensities

S. Steiner, J. C. Burnham,1 S. F. Conti, and R. L. Lester, J Bacteriol. 103, 500-503



Under high light intensity the vesicles disappear but there is no change in the amount of phospholipid/cell as compared to the cells below.

How would you interpret These results?



Chromatium packed with Photosynthetic vesicles. All of which are associated with the surface membrane

Inclusions-termed granules and vesicles (characteristic of some organisms not present in most (aside from ribosomes)).

a. glycogen

b. polyphosphate- termed metachromatic granules or volutin

c. chromatophores

d. vesicles that contain poly-β –hydroxybutyrate

e. lipid deposits

f. ribosomes (70S= 50S + 30S)

g. magnetic inclusions (Fe_3O_4)

Endospores

Vegetative cells of certain species *Bacillus and Clostridium* produce resting stages called endospores.. These spores help the organisms overcome an adverse situation and are not very useful for reproduction since there is only a single spore per cell. In contrast, fungi typically produces numerous spores and are therefor useful as a means of reproduction.

Endospores are highly dehydrated and it is likely this properties that makes them so resistant to heat, drying, acids and bases, and even radiation.

Sporulation

http://www.youtube.com/watch?v=UHsqFjP1dZg&feature=related

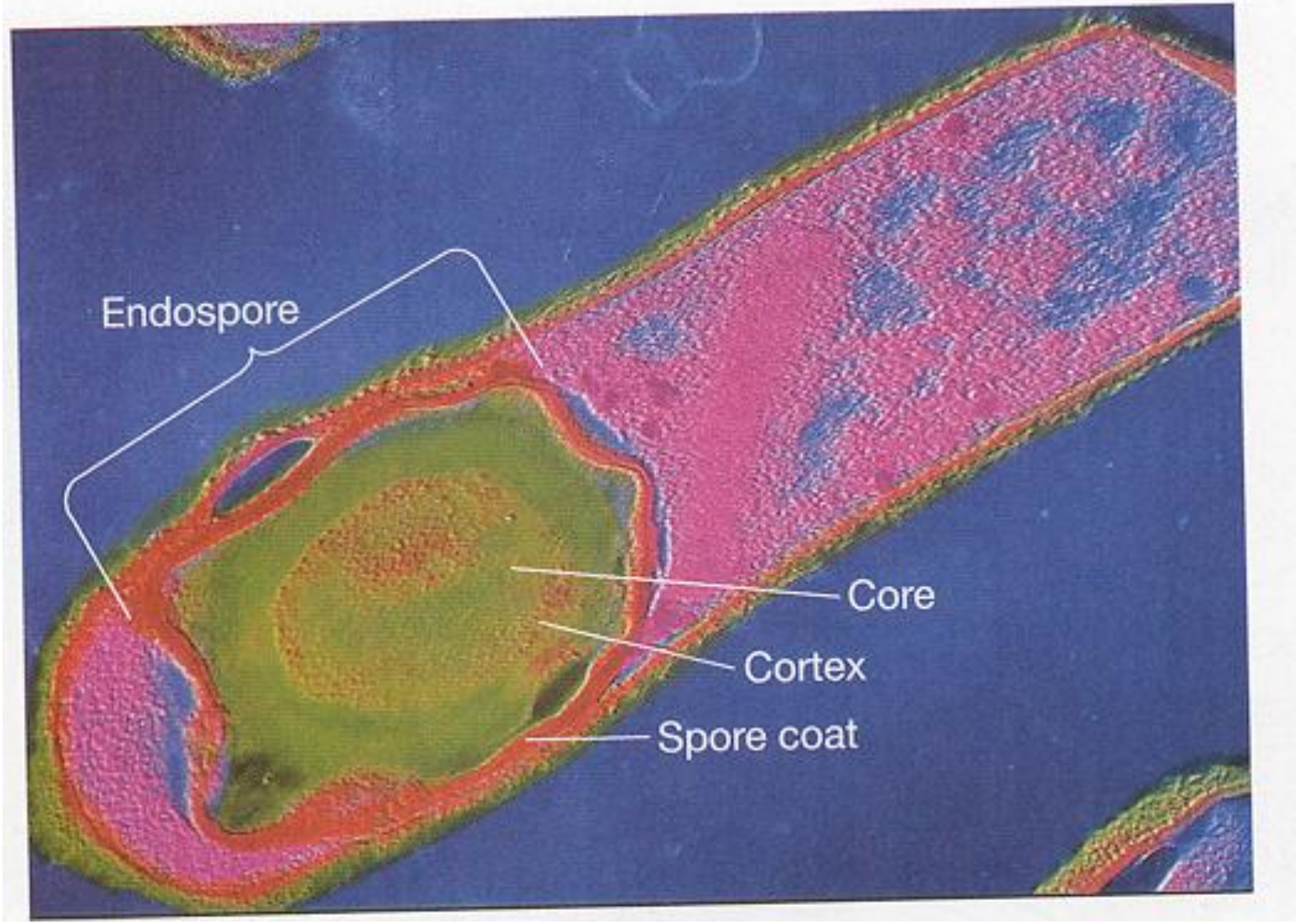
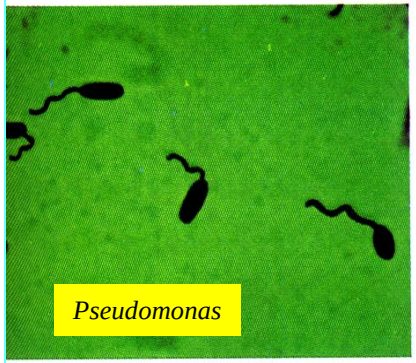


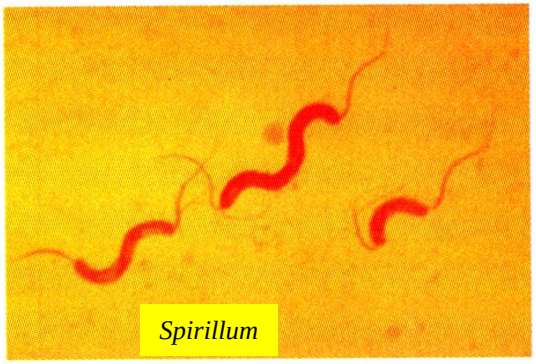
Fig. 4.11 **Endospores**

Dipicolinic acid (pyridine-2,6-dicarboxylic acid) is a chemical compound which composes 5% to 15% of the dry weight of bacterial spores. It is implicated as responsible for the heat resistance of the endospore However, mutants resistant to heat but lacking dipicolinic acid have been isolated, suggesting other mechanisms contributing to heat resistance are at work. Spore core dehydration is a primary determinant of heat resistance. Remember that hydrolysis is the major mechanism by which complex molecules are broken down by enzymatic activity. Hence, if there is no water there is no hydrolysis.

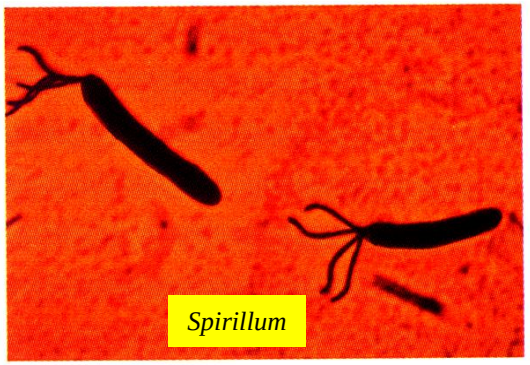
EXTERNAL STRUCTURES



Monotrichous single flagellum at one end

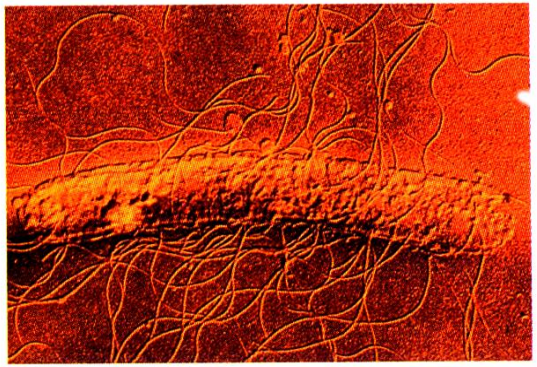


Amphitrichous- single flagellum at each end



Lophotrichous-tuft of flagella at one or both ends

Peritrichous- Flagella distributed all over



Scanning SEM of peritrichous

Fig. 4.12 Arrangement of bacterial flagella

The bacterial flagellum is driven by a rotary engine (the *Mot complex*) made up of protein, located at the flagellum's anchor point on the inner cell membrane. The engine is powered by proton motive force, i.e., by the flow of protons (hydrogen ions) across the bacterial cell membrane due to a concentration gradient set up by the cell's metabolism (in *Vibrio* species there are two kinds of flagella, lateral and polar, and some are driven by a sodium ion pump rather than a proton pump[18]). The rotor transports protons across the membrane, and is turned in the process.

Flagellar structure and function

http://www.youtube.com/watch?v=Ey7Emmddf7Y

Cholera Epidemic Envelops Coastal Slums in West Africa DAKAR, Senegal — A fierce cholera epidemic is spreading through the coastal slums of West Africa, killing hundreds and sickening many more in one of the worst regional outbreaks in years, health experts said. Cholera, transmitted through contact with contaminated feces, was made worse this year by an exceptionally heavy rainy season that flooded the sprawling shantytowns in Freetown and Conakry, the capitals of Sierra Leone and neighboring Guinea. In both countries, about two-thirds of the population lack toilets, a potentially lethal threat in the rainy season because of the contamination of the water supply. Doctors Without Borders said there had been nearly twice as many cholera cases so far this year as there were in the same period in 2007 in Sierra Leone and Guinea, when it said the area experienced its last major outbreak. Already, more than 13,000 people suffering from the disease's often fatal symptoms — diarrhea, vomiting and severe dehydration — have been admitted to hospitals in the two nations' capitals, and 250 to 300 have died, Doctors Without Borders said. In the 14 countries of West and Central Africa there have been 40,799 cholera cases this year, and 846 deaths, with over half the reported cases originating in the Democratic Republic of Congo. Unicef said those figures were comparable to the regional totals for 2011, when there were more than 105,000 cases and nearly 3,000 deaths in what was considered to be one of the greater region's worst cholera epidemics. "If your area is flooded with rainwater, and if people are defecating in the open, it will get into the water supply," said Jane Bevan, a regional sanitation specialist for Unicef. "We know governments have the money for other things. I'm afraid sanitation is never given the priority it deserves."

India reports new TB strain resistant to all drugs **Indian doctors have reported the country's first cases of "totally drug-resistant tuberculosis," a long-feared and virtually untreatable form of the killer lung disease.** **It's not the first time highly resistant cases like this have been seen. Since 2003, patients have been documented in Italy and Iran. It has mostly been limited to impoverished areas, and has not spread widely. But experts believe there could be many undocumented cases. No one expects the Indian TB strains to rapidly spread elsewhere. The airborne disease is mainly transmitted through close personal contact and isn't nearly as contagious as the flu. Indeed, most of the cases of this kind of TB were not from person-to-person infection but were mutations that occurred in poorly treated patients.**

No one expects the Indian TB strains to rapidly spread elsewhere. The airborne disease is mainly transmitted through close personal contact and isn't nearly as contagious as the flu. Indeed, most of the cases of this kind of TB were not from person-to-person infection but were mutations that occurred in poorly treated patients.

What's more, there's a debate within the public health community about whether to even label TB infections as totally drug resistant. The World Health Organization hasn't accepted the term and still considers the cases to be what's now called extensively drug-resistant TB, or XDR. However, Dr. Paul Nunn, a coordinator at the WHO's Stop TB Department in Geneva, said there is ample proof that these virtually untreatable cases do exist. Ordinary TB is easily cured by taking antibiotics for six to nine months. However, if that treatment is interrupted or the dose is cut down, the stubborn bacteria battle back and mutate into a tougher strain that can no longer be killed by standard drugs. The disease becomes harder and more expensive to treat. If a TB case is found to be resistant to the two most powerful anti-TB drugs, the patient is classified as having multi-drug-resistant TB (MDR). An even worse classification of TB — one the WHO accepts — is extensively drug-resistant TB (XDR), a form of the disease that was first reported in 2006 and is virtually resistant to all drugs.

Medical Opt-Out Rates for Vaccines Vary by State Rates of medical exemptions from vaccination requirements are higher in states where exemptions are easier to get, potentially compromising immunity and posing a threat to other children, according to public health experts at Emory University. The appropriate use of medical exemptions is important to maintaining sufficient **herd immunity**," Saad Omer, assistant professor of global health, epidemiology, and pediatrics at Emory University Schools of Public Health and Medicine, writes in the study. Herd immunity refers to the resistance to the spread of infectious disease in a group because susceptible members. are few. It explains how nonvaccinated people are protected when a significant portion of a population is vaccinated. "More importantly, they add to existing pockets of susceptibility. It is known that immunizations exemptors cluster geographically, increasing the possibility for local areas of increased disease incidence." With herd immunity, infections are unlikely to transfer from person to person because most people are immune. This then disrupts the chain of transmission that could infect a person who did not receive a vaccine or did not respond to it. People with compromised immune systems, such as infants, the elderly, cancer patients or people with other immune disorders, are typically protected by herd immunity. Also protected are those who, for one reason or another, can't, for medical reasons, get vaccinated. People with compromised immune systems, such as infants, the elderly, cancer patients or people with other immune disorders, are typically protected by herd immunity. Also protected are those who, for one reason or another, can't, for medical reasons, get vaccinated.

"Children with valid medical exemption need to be protected ... by insuring high coverage rates among the rest of the population,"

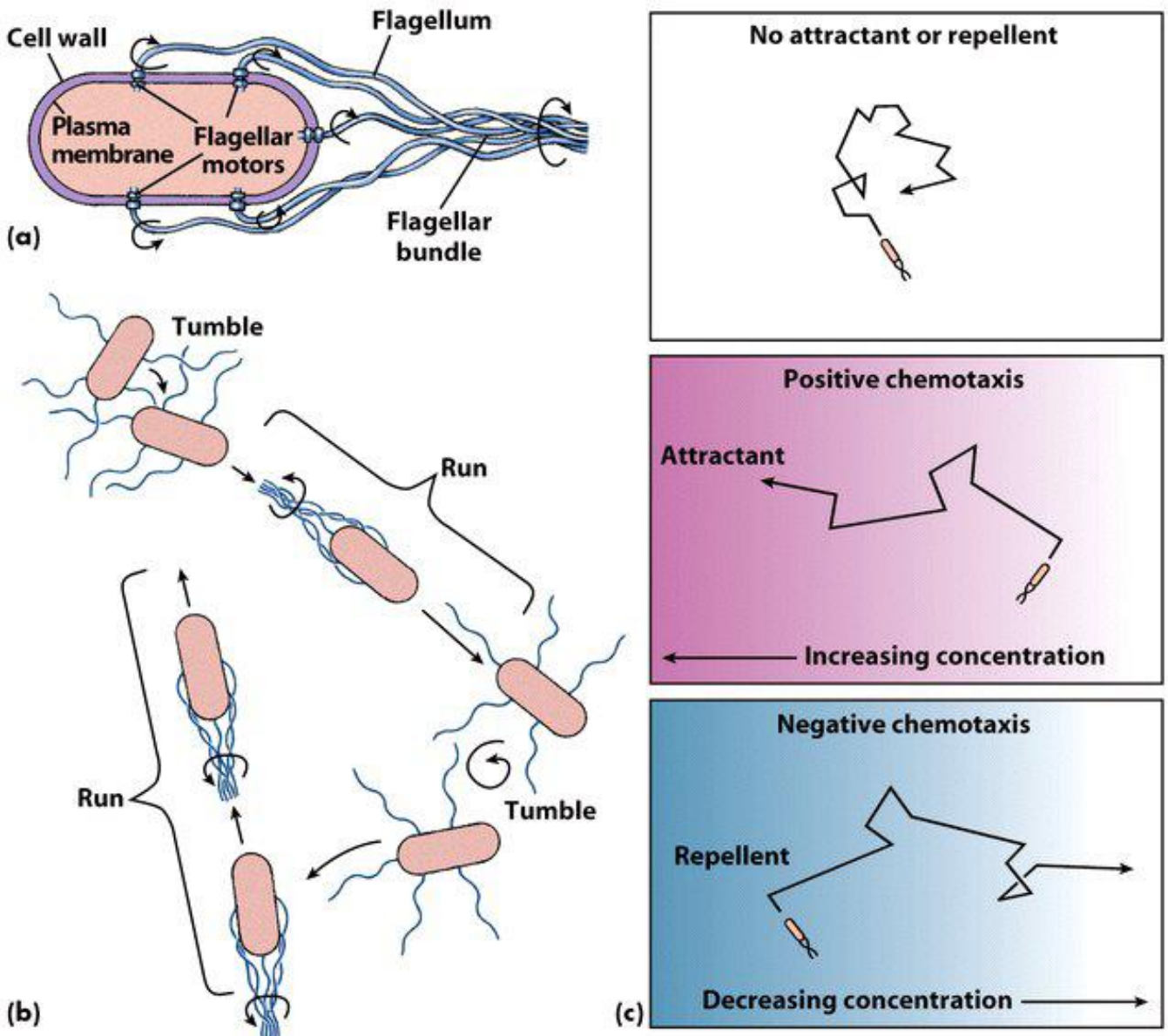


Figure 4-14 Microbiology, 6/e

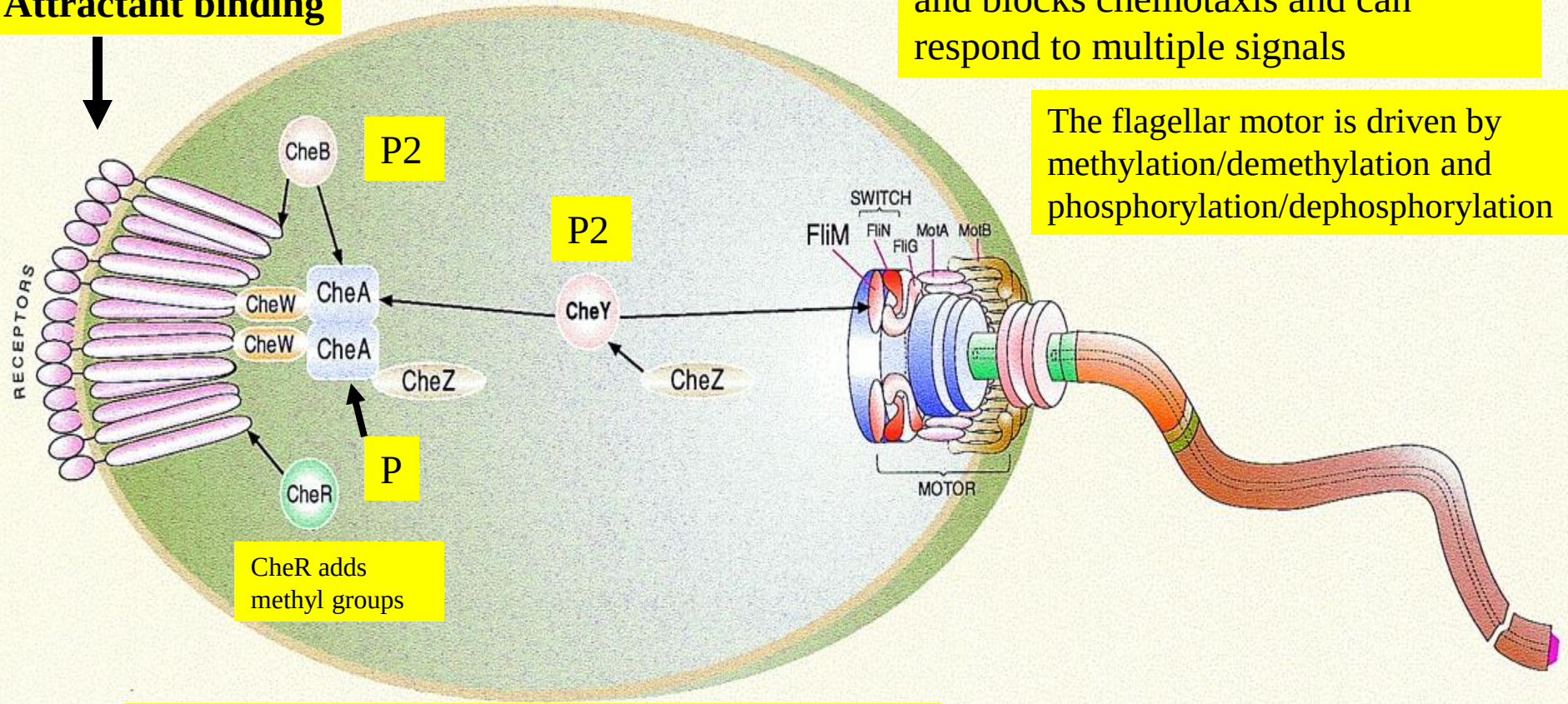
A primitive but effective mode of cells being able to recognize a chemical signal. As organisms evolved that kind of signal recognition became more important for a wide range of extracellular signals.

Fig. 4.14 **chemotaxis-above is positive chemotaxis**

Attractant binding

Signal transduction that both triggers and blocks chemotaxis and can respond to multiple signals

The flagellar motor is driven by methylation/demethylation and phosphorylation/dephosphorylation



CheR adds methyl groups

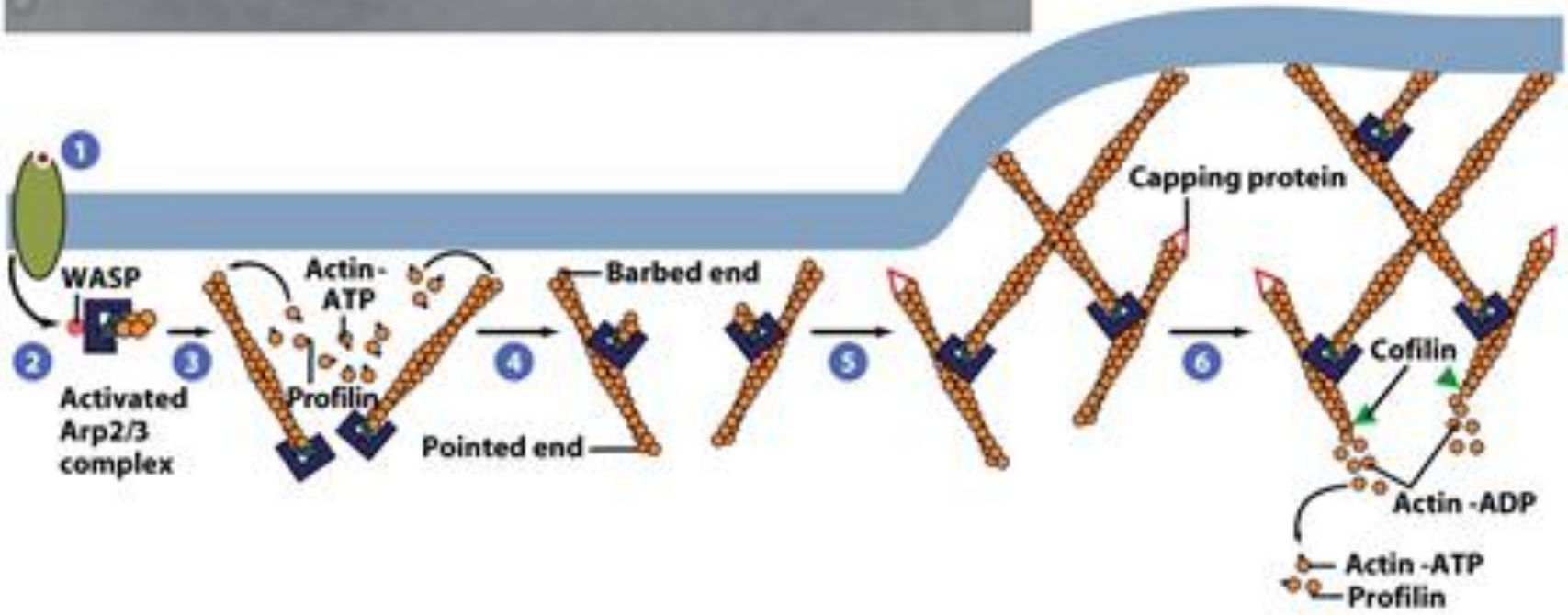
Chemotactic activation pathway- not in your text

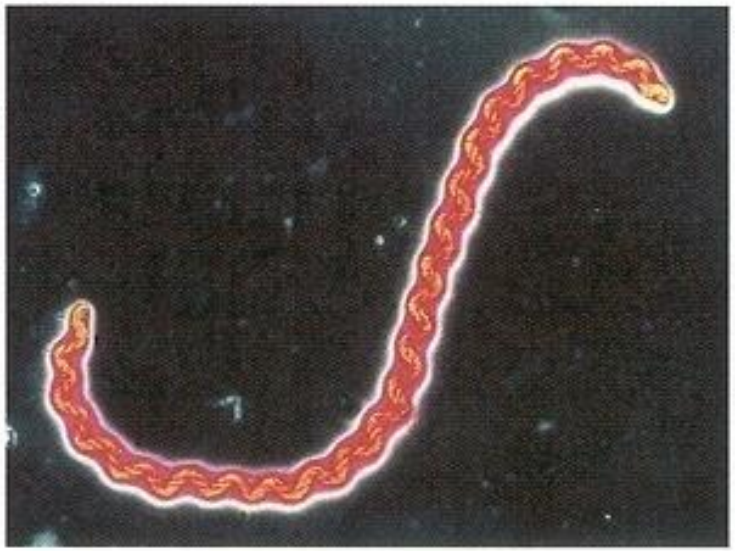
Take home lesson: bacterial chemotaxis, is a signal transduction system which involves phosphorylation/dephosphorylation and methylation/demethylation regulatory controls. Do not worry about the details of this diagram just understand the major points indicated above, i.e., signal transduction system and generally how it functions.

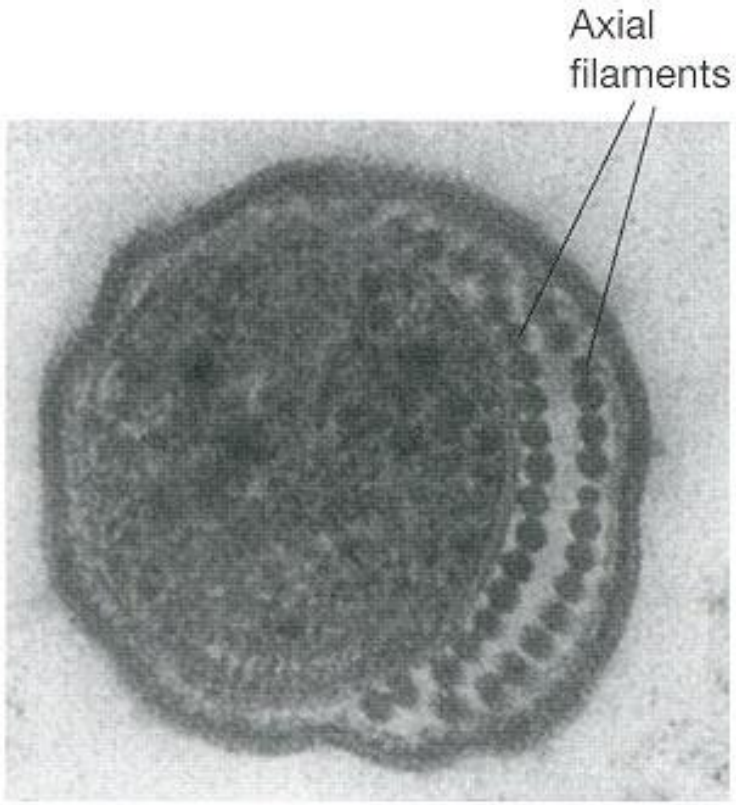
Neutrophil chemotaxis

http://www.youtube.com/watch?v=EpC6G_DGqkI

Major steps in formation of a lamellipodium





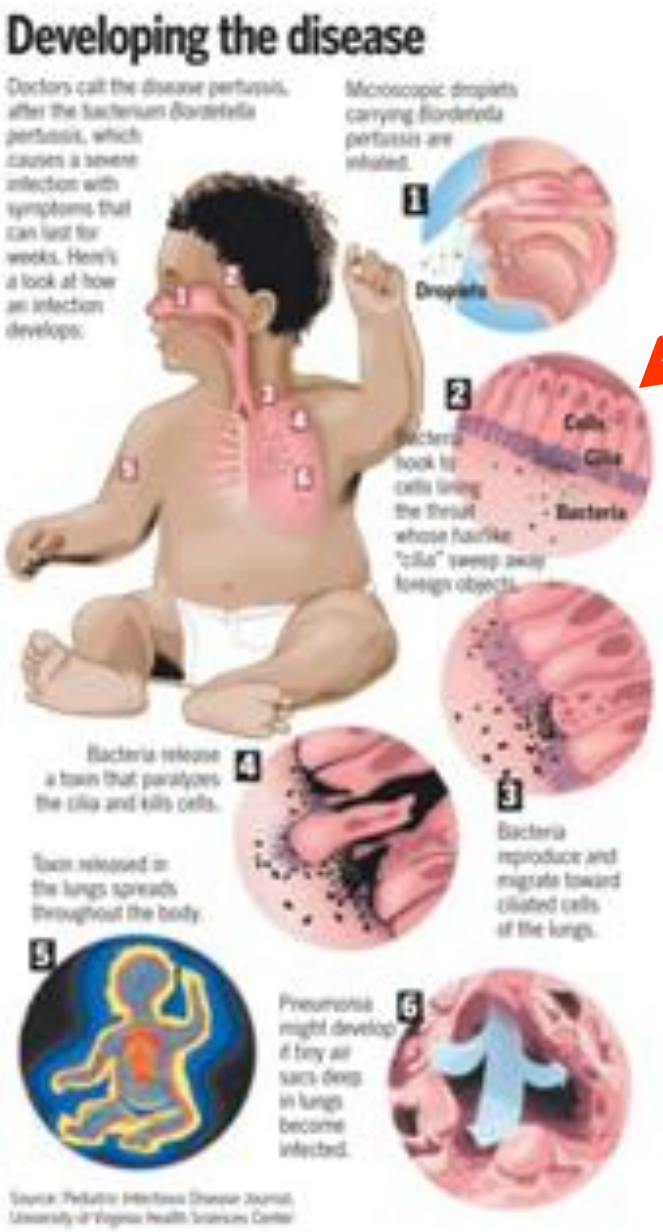


Spirochetes have **axial filaments or endoflagellum**, instead of flagella that extend beyond the cell wall. They are contained within a sheath and cause the rigid spirochete body to rotate like a corkscrew when they twist inside the outer sheath. Put lophotrichous flagella on the side of a bacterium and wrap plastic wrap around it- gives you some idea of how it works.

Fig. 4.15 Axial filaments, or endoflagella

Pili- are tiny hollow projections

Attachment pili.- help bacteria adhere to surfaces and contribute to the pathogenicity of certain bacteria. For example, *Neisseria. gonorrhea*, enterotoxigenic *Escherichia.coli* among others.



Organism must attach to cells to cause disease- fimbrae or pili are very important for the attachment

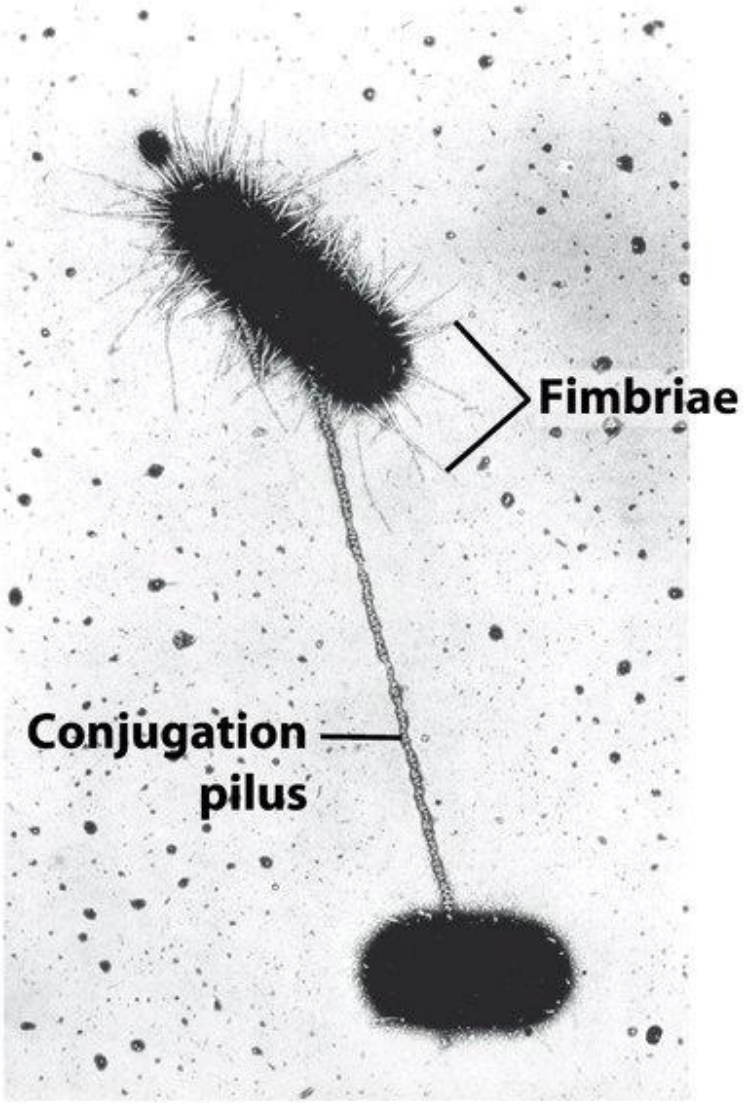
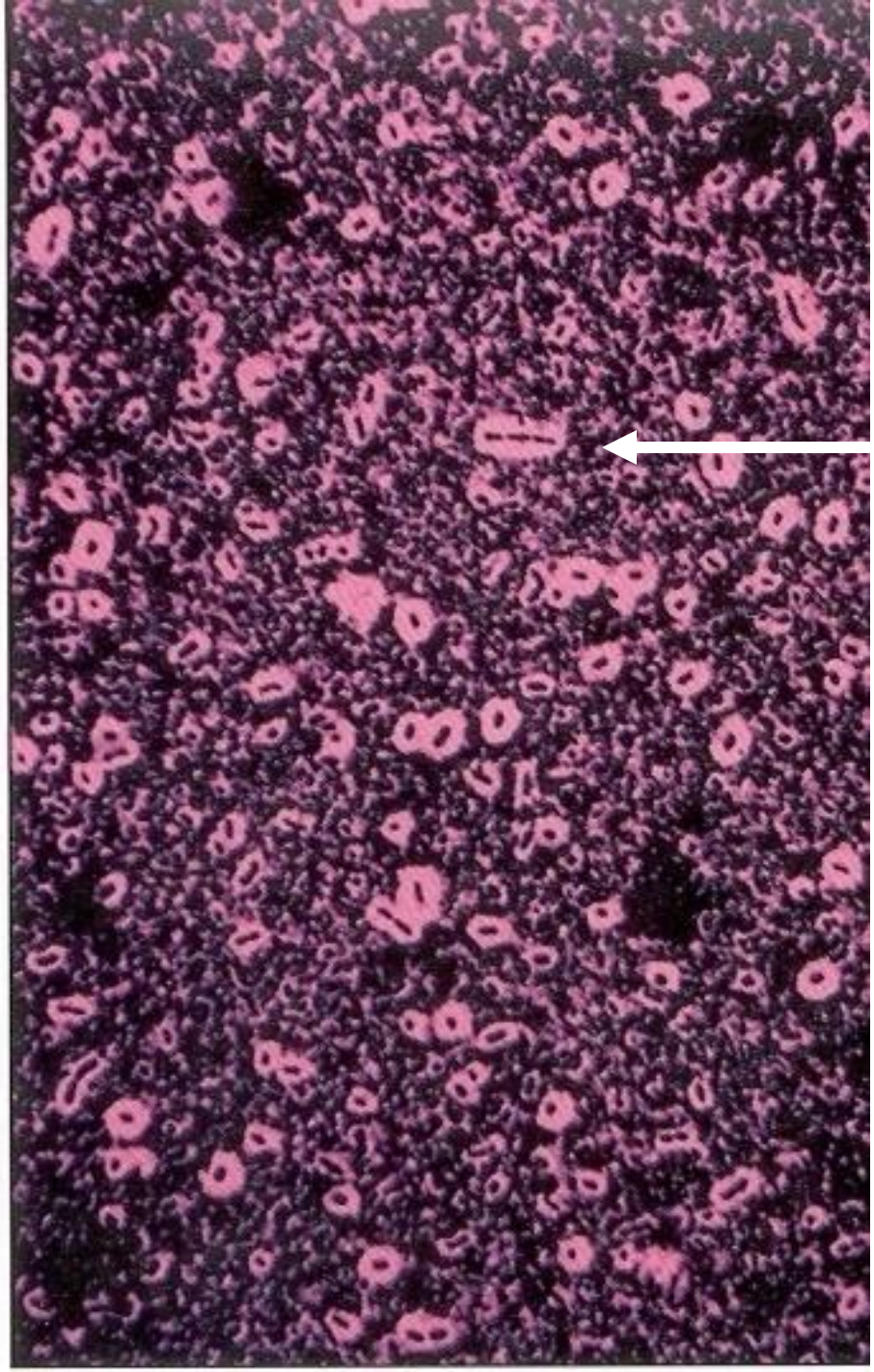


Figure 4-16 Microbiology, 6/e

Fig. 4.16 Pili.

Conjugation pili (or sex pilus) hollow tube through which DNA is transferred from + to - cell during bacterial mating



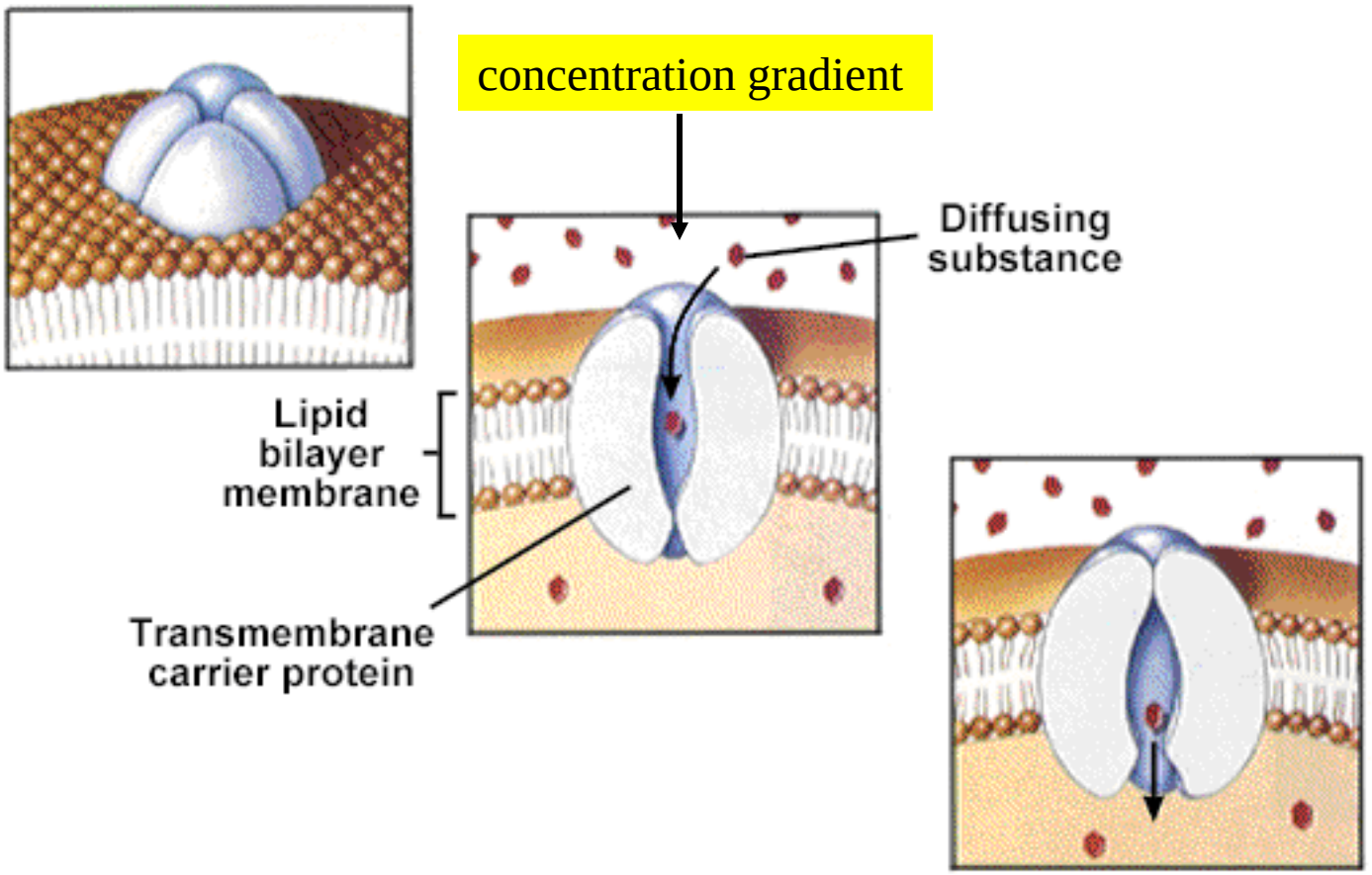
Capsule surrounding a rod-shaped bacterium

- a secreted protective structure outside the cell wall of an organism. Capsule is very important in the pathogenesis of a number of organisms such as, *Streptococcus pneumonia*, *Bacillus anthracis*.

Figure 3.3 of negative-staining of capsules

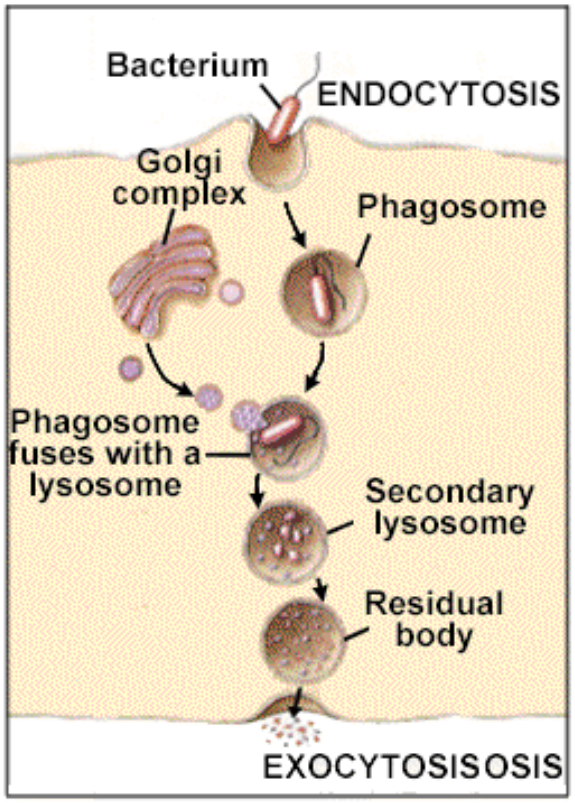
Slime layer- **less tightly bound to the cell wall and usually thinner than a capsule. When present it protects the cell against drying, helps trap nutrients near the cell, and sometimes binds cells together. Slime layers allow bacteria to adhere to objects in their environments, such as rock surfaces, teeth, or the root hairs of plants, so that they can remain near sources of nutrients or oxygen.**

EUKARYOTIC CELLS- I will not cover this material because it is the focus of BIO 315- Cell Biology. Moreover, most of what you need to know for this course has been taught in BIO 150 or its equivalent.



Facilitate diffusion Carrier protein molecules aid in the movement of substances through the cell membrane, but only down a concentration gradient. This process does not require the expenditure of energy

Fig. 4.29 **Facilitated diffusion**



Endocytosis and exocytosis- endocytosis is the process of taking materials into the cell; exocytosis is the process of releasing materials from the cell. **Amantadine- blocks virus uptake by endocytosis. The mechanism of Amantadine's antiviral activity involves interference with a viral protein, M2 (an ion channel), which is required for the viral particle to become "uncoated" once taken inside a cell by endocytosis.**

Fig. 4.33 **Endocytosis and exocytosis- associated with eukaryotic cells- (viruses are often taken up in this manner)**