

# ESSENTIAL CONCEPTS OF METABOLISM

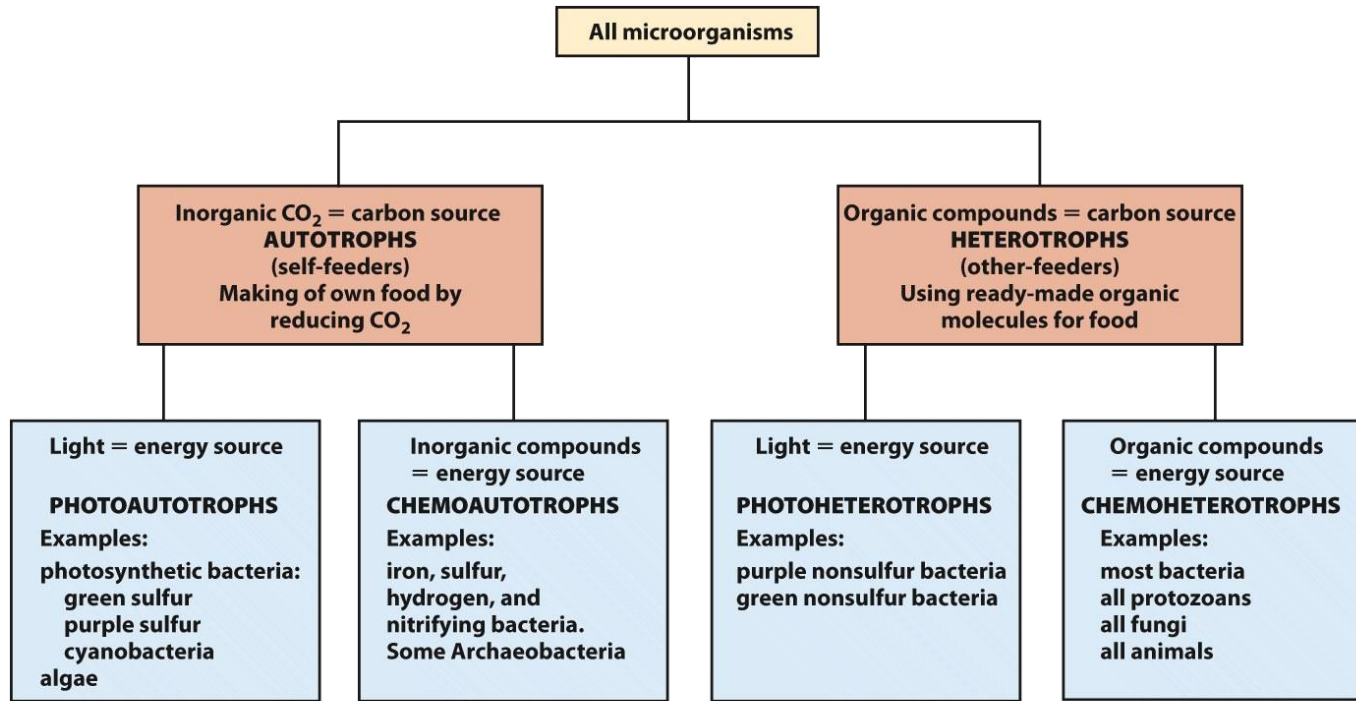
## CHAPTER 5



Courtesy Jacquelyn G. Black

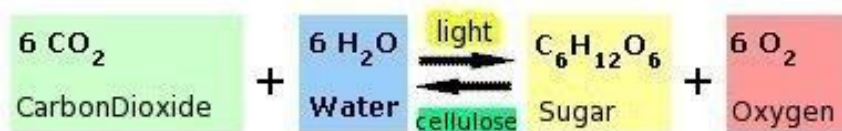
# Microbial Metabolism

- Autotrophy versus heterotrophy
- Chemo- versus Photo-



© 2012 John Wiley & Sons, Inc. All rights reserved.

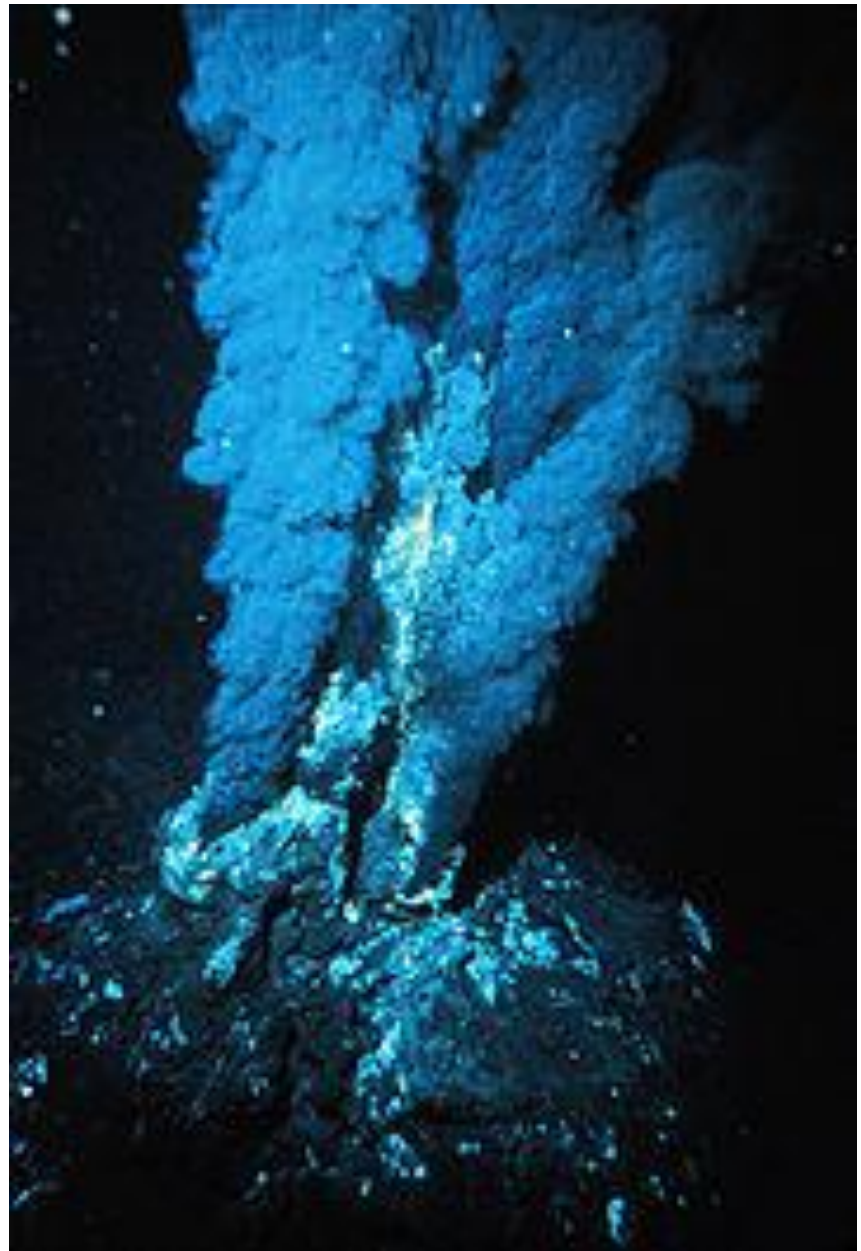
Like most other photosynthetic bacteria, purple bacteria do not produce oxygen, because the reducing agent (electron donor) involved in photosynthesis **is not water**. In some, called purple sulfur bacteria, it is either sulfide or elemental sulfur. The others, called purple non-sulfur bacteria, typically use hydrogen.



Plant photoautotroph- uses water as a reducing agent

Fig. 5.2 The main types of energy-capturing metabolism

A **black smoker** or **sea vent** is a type of [hydrothermal vent](#) found on the [ocean floor](#). They are formed in fields hundreds of meters wide when [superheated](#) water from below [Earth's crust](#) comes through the ocean floor. This water is rich in dissolved [minerals](#) from the crust, most notably [sulfides](#). When it comes in contact with cold ocean water, many minerals precipitate, forming a black chimney-like structure around each vent. The metal sulfides that are deposited can become [massive sulfide ore deposits](#) in time. **The water at a vent can reach 400 °C (752 °F)**, but does not usually boil at the seafloor because the water pressure at that depth exceeds the [vapor pressure](#) of the aqueous [solution](#). The water is also extremely [acidic](#), often having a [pH](#) value as low as 2.8 — approximately that of [vinegar](#). Each year  $1.4 \times 10^{14}$  kg (370 trillion gallons) of water is passed through black smokers. Many think that life on earth started in these vents-Arachae



A black smoker in the Atlantic Ocean

<http://www.youtube.com/watch?v=XotF9fzo4Vo&feature=related>

This video shows and describes more about the vents.

Europa, with a surface temperature of  $-260^{\circ}\text{C}$  has liquid ocean which could support life. This observation (liquid ocean) coupled with chemoautotrophs opens all kinds of possibilities for life in space.



**Rosacea May Be Caused by Bacteria** Bacteria living within the mites that dwell in normal human skin may play a role in causing rosacea — a condition that turns patches of skin on the face red or bumpy, recent research suggests. About 3 percent of people have rosacea, although the condition is more common in fair-skinned people, and those with weakened immune systems. While it doesn't affect a person's general health, it can be painful or embarrassing, said Kevin Kavanagh, of the National University of Ireland, Maynooth. Kavanagh and colleagues reviewed recent evidence showing rosacea may be triggered by bacteria that live within tiny mites on the skin. Mites of a species called *Demodex folliculorum* live harmlessly in normal skin, dwelling inside structures surrounding hair follicles. Research now shows rosacea patients have more of these mites in their skin than those without rosacea, Kavanagh said. Moreover, these bacteria are sensitive to the antibiotics used to treat rosacea. (Antibiotics have been used to treat rosacea, but mainly for their anti-inflammatory effects, not because they kill bacteria.)

"When the mites die, the bacteria are released and leak into surrounding skin tissues — triggering tissue degradation and inflammation," Kavanagh said.

"Targeting these bacteria may be a useful way of treating and preventing this condition," Kavanagh said. Kavanagh also noted some pharmaceutical companies are already developing therapies to control the population of mites in the face of patients.

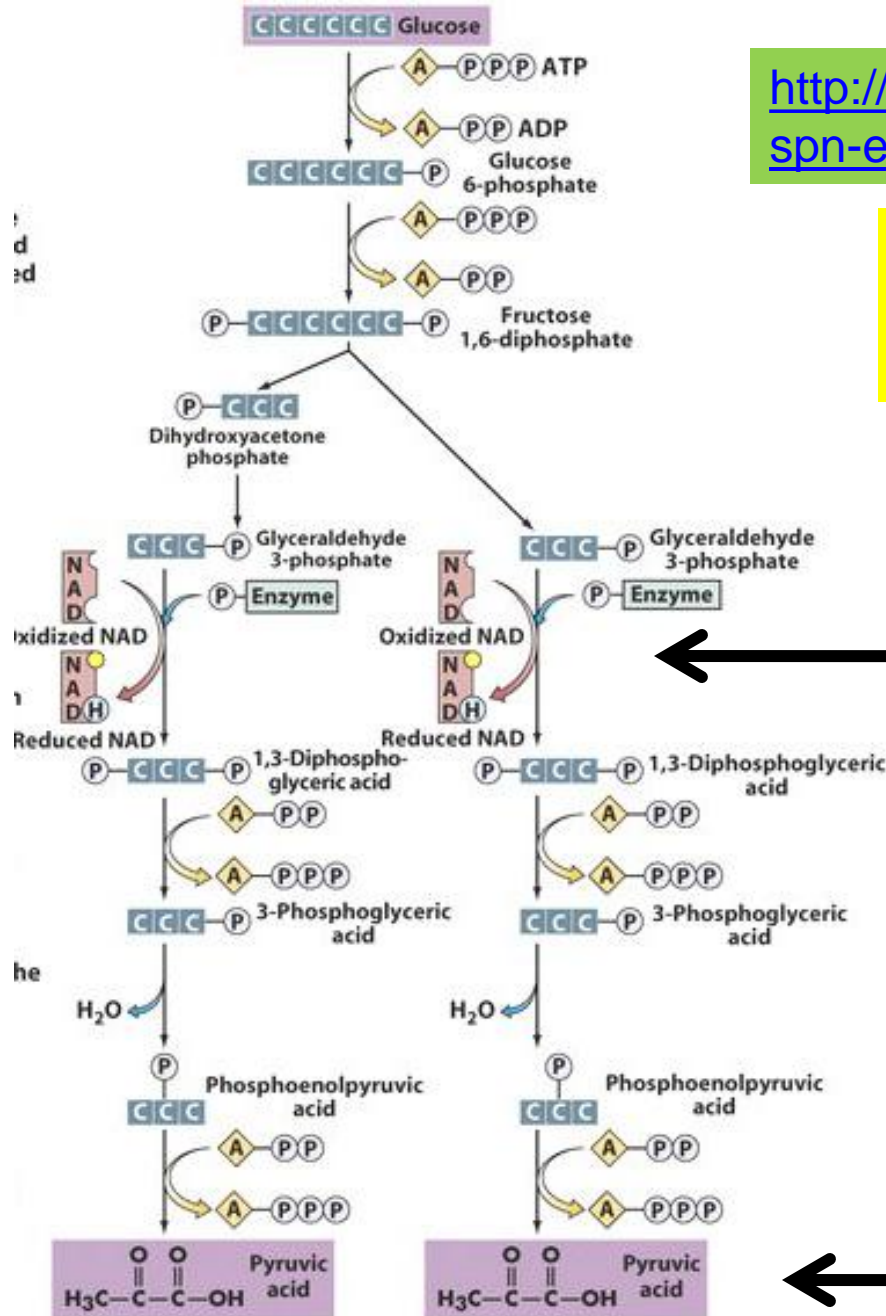
Kavanagh's review is published today (Aug. 29) in the *Journal of Medical Microbiology*.

New Virus Tied to Ticks Poses Puzzle for DoctorsThe scientists have been trying to find out how this farmer and another unfortunate Missouri man contracted a severe viral disease — a new one, never seen before. It put both men in the hospital for more than a week with high fevers, diarrhea, nausea, muscle pain, low blood cell counts and liver abnormalities. Scientists at the Centers for Disease Control and Prevention think the men were infected by lone star ticks, meaning that there may be a frightening new addition to the list of tick-borne dangers that includes Lyme disease, babesiosis and Rocky Mountain spotted fever. But despite scouring the countryside, investigators have found neither ticks nor animals carrying the new virus. **They have named it the Heartland virus, for the hospital and region where it was found. So far, the two men in Missouri are the only humans known to have been infected. The cases are a stark reminder that new infectious diseases can still emerge, frequently from unknown bacteria and viruses that lurk in animals.** The disease first appeared in Missouri in June 2009, when Robert Wonderly, then 57, a factory worker who lives on a farm, suddenly fell ill. For several days he felt weak, feverish and irritable. Then his chest began to ache. Tests at Heartland Regional Medical Center in St. Joseph ruled out a heart attack, but Mr. Wonderly just got sicker. His fever spiked to 104 degrees. When his wife told a nurse that she had found a tick embedded in his skin the day before he became ill, the nurse called in an infectious diseases expert, Dr. Scott M. Folk. Dr. Folk immediately suspected ehrlichiosis, a bacterial disease that is carried by ticks and is common in the area. So he prescribed the standard treatment, the antibiotic doxycycline. In the meantime, he sent a sample of Mr. Wonderly's blood to Atlanta to be tested at the C.D.C. **But C.D.C. researchers found something else growing in the lab cultures: a virus — a member of a group called phleboviruses, which are carried by sand flies, mosquitoes or ticks.** The new virus is closely related to one recently discovered in China that has caused severe illness and even some deaths. They are the only two tick-borne phleboviruses known to cause disease in humans.

**India marks milestone in fight against polio** NEW DELHI (AP) — India will celebrate a full year since its last reported case of polio on Friday, a major victory in a global eradication effort that seemed stalled just a few years ago. If no previously undisclosed cases of the crippling disease are discovered, India will no longer be considered polio endemic, leaving only Pakistan, Afghanistan and Nigeria on that list. This is a game changer in a huge way," said Bruce Aylward, head of the World Health Organization's global polio campaign. It also helps India, which bills itself as one of the world's emerging powers, shed the embarrassing link to a disease associated with poverty and chaos, one that had been conquered long ago by most of the globe. The polio virus, which usually infects children in unsanitary conditions, attacks the central nervous system, sometimes causing paralysis, muscular atrophy, deformation and, in some cases, death. With its dense population, poor sanitation, high levels of migration and weak public health system, India had been seen as "the perfect storm of polio," Aylward said. Even some vaccinated children fell ill with the virus because malnutrition and chronic diarrhea made their bodies too weak to properly process the oral vaccine. In 2009, India had 741 cases. That plunged to 42 in 2010. Last year, there was a single case, an 18-month-old girl named Ruksana Khatun who fell ill in West Bengal state Jan. 13. She was the country's last reported polio victim. Philanthropist Bill Gates, whose foundation has made polio eradication a priority, hailed India's achievement as an example of the progress that can be made on difficult development problems.

[http://www.youtube.com/watch?v=mgH\\_spn-ew](http://www.youtube.com/watch?v=mgH_spn-ew)

Key elements associated with various types of bacterial fermentation when starting with glucose as a food source



Production of 2 X NADH + H<sup>+</sup>

I assume that you have already been through glycolysis in several courses and therefore I will not repeat it, in its entirety, in this course

Production of 2 pyruvic acids

Fig. 5.11 The reactions of glycolysis



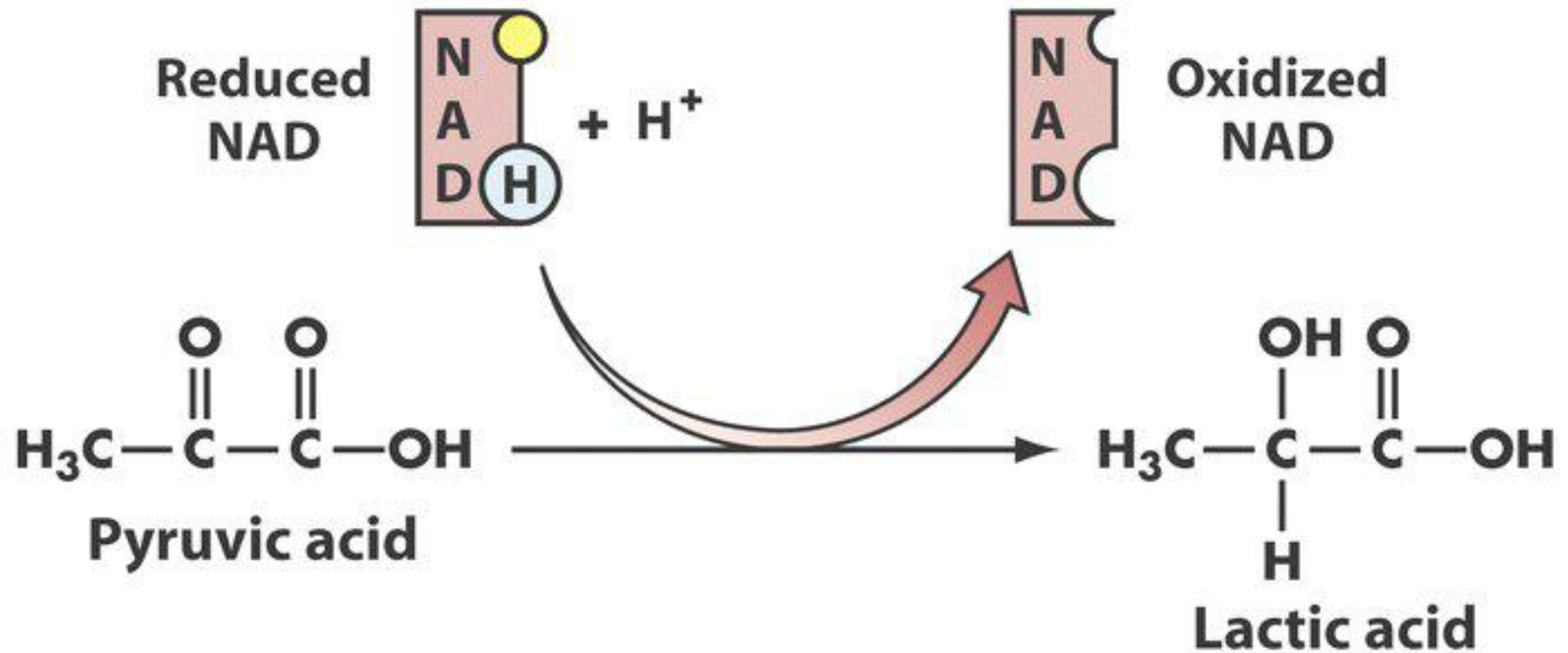


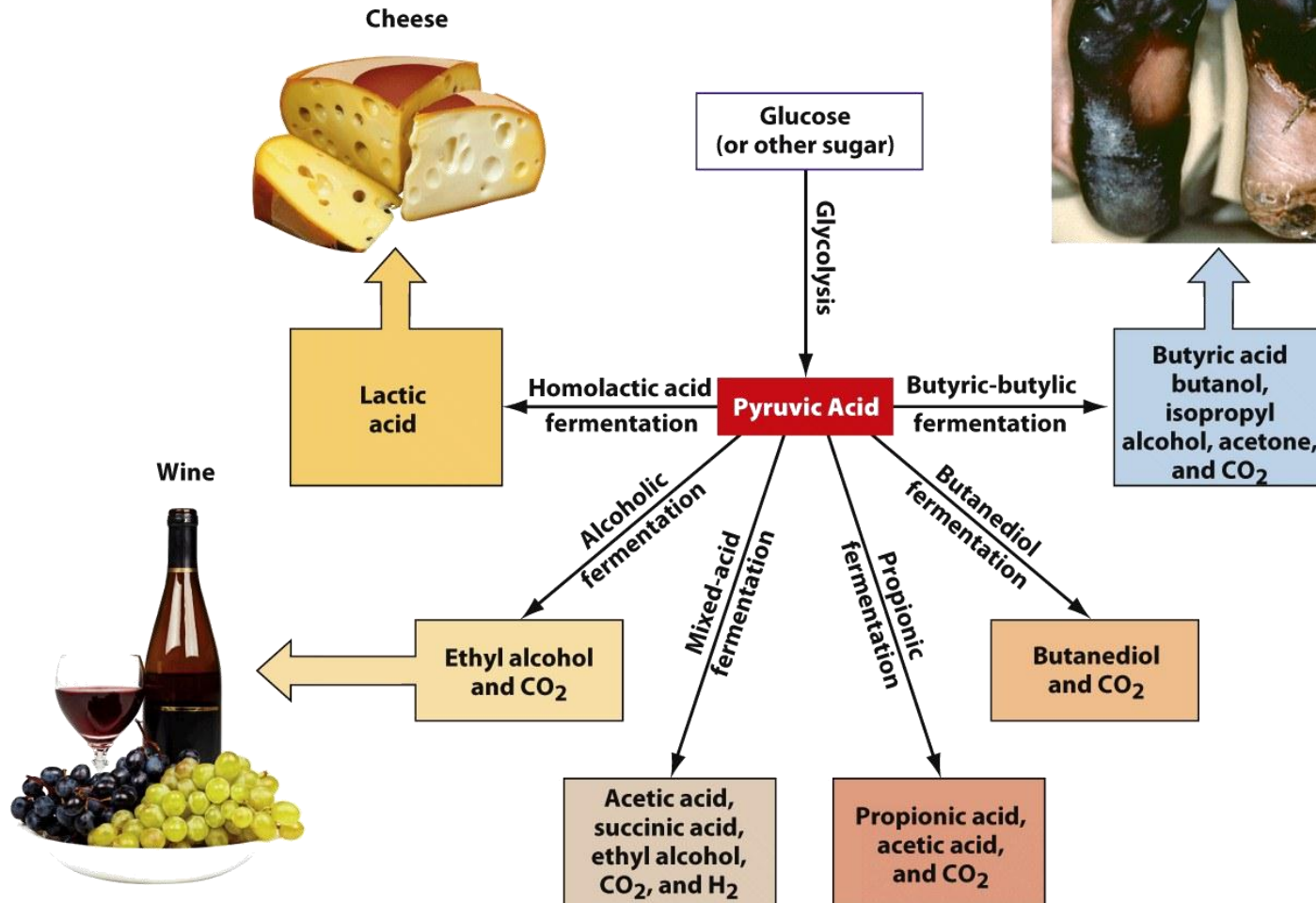
Figure 5-13 Microbiology, 6/e  
© 2005 John Wiley & Sons

Fig. 5.13 Homolactic acid fermentation

# Acid/Alcohol Fermentation Pathways

Know the various types of bacterial fermentation

Feet darkened by gangrene



© 2012 John Wiley & Sons, Inc. All rights reserved. Photos: © Alexey Romanov/iStockphoto; © Vassiliy Mikhailin/iStockphoto; Mike Pares/Custom Medical Stock Photo, Inc.

Fig. 5.12 Fermentation Pathways

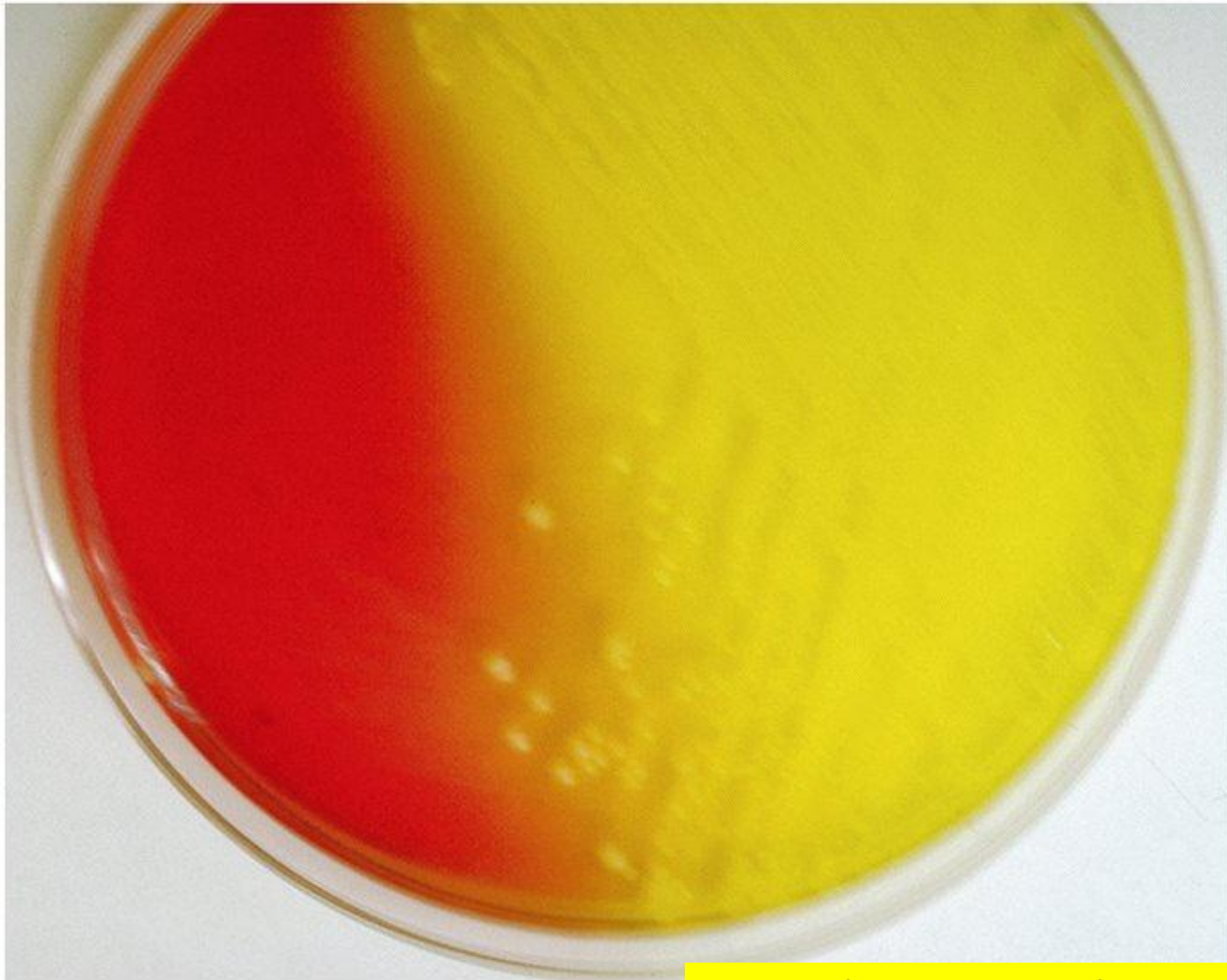


Figure 5-15 Microbiology, 6/e  
© 2005 John Wiley & Sons

Mannitol fermentation is often used in bacterial identification-

A positive (yellow) mannitol-fermentation

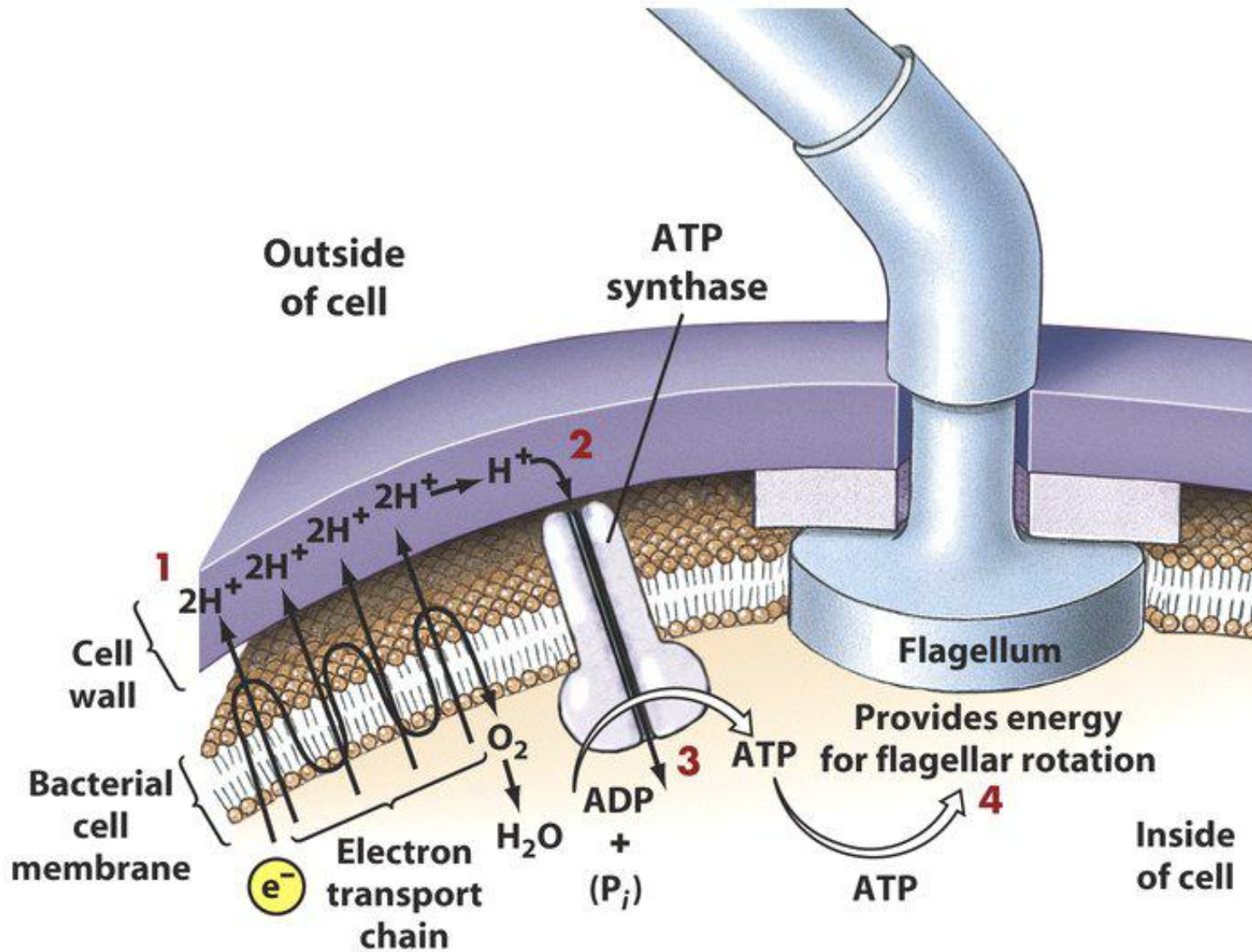


Figure 5-20 Microbiology, 6/e  
© 2005 John Wiley & Sons

## Chemiosmosis



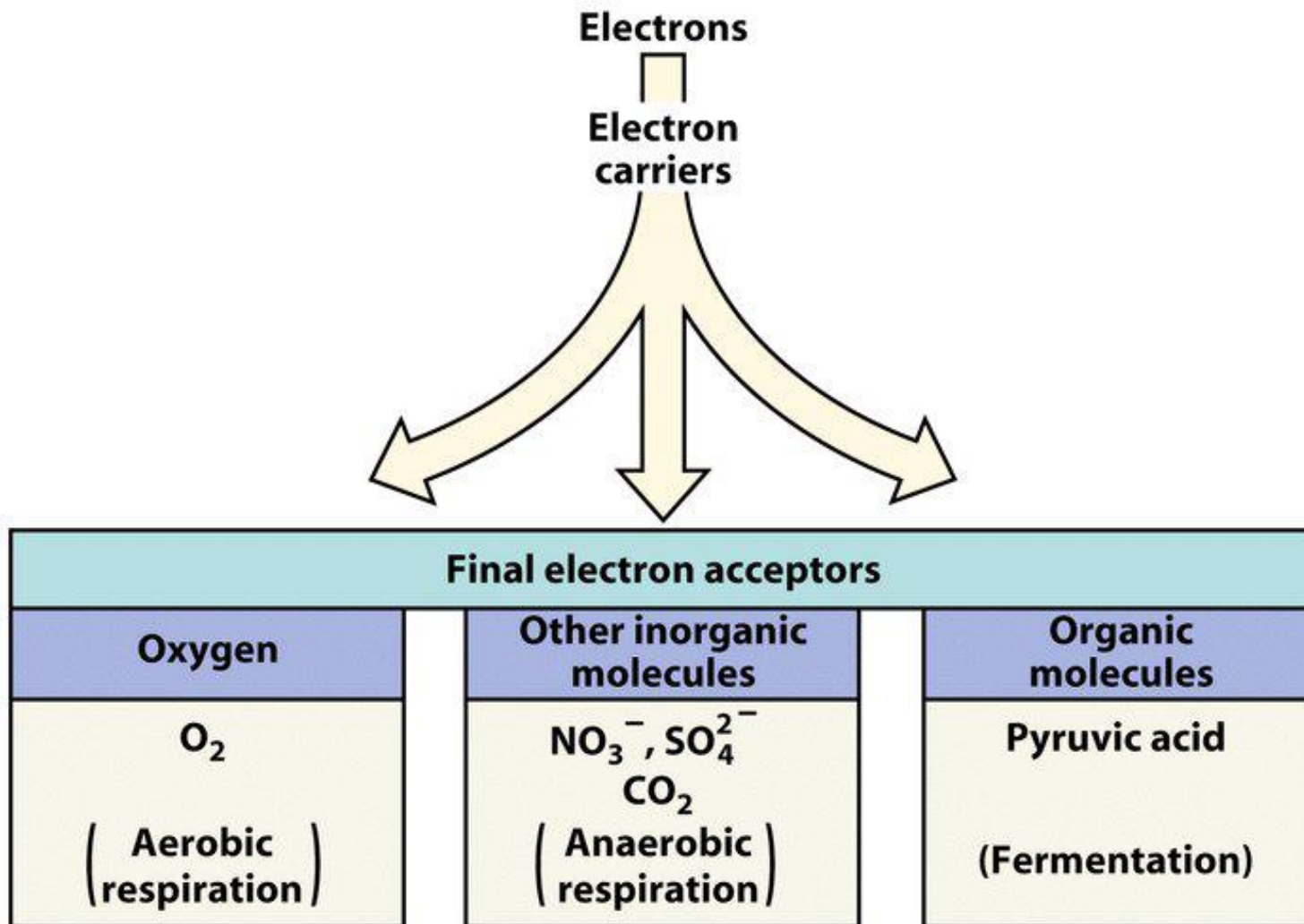


Figure 5-21 Microbiology, 6/e  
© 2005 John Wiley & Sons

Final electron acceptors- aerobic respiration, anaerobic respiration and fermentation have different final electron acceptors- video below anaerobic respiration

<http://www.youtube.com/watch?v=uTILYY-NxxE>