of ATP from the continual cycling of glycolysis, using fermentation to regenerate NAD^+. If the cell cannot ferment, and cannot use an alternate electron acceptor, then it will most likely die.

Concept Building Questions

1. The simple answer as to why microbes can't import whole proteins inside rather than make them is that proteins are simply too large to pass through the outer structures microbes possess. Prokaryotes have complex cell walls that are breached only by special channels or pores. Other microbes have cytoplasmic membranes at the very least (some will also have other structures) that are also impassible by large proteins. Proteins cannot diffuse through a membrane, nor are the channels, pores, or other transporters large enough to allow such big molecules through. If they were, the holes would be so big in the membranes of microbes that everything else could pass in and out of the cell with little control and most likely the cell would burst because of its inability to control movement of small molecules.
2. Enzyme-substrate complexes will be formed via weak interactions between the two: hydrogen bonds, electrostatic associations, and some conformationally derived interactions. Essentially, those bonds that can be easily formed and reformed will be used in the enzyme-substrate complex. Covalent bonds of any sort cannot be used to establish this complex because they are not readily dispensable. A given enzyme may be needed to break a covalent bond in a substrate, but it is not going to be able to work on the substrate to the extent it needs to do that if it is itself permanently bound to the substrate. Thus, covalent associations would prevent the enzyme from moving the substrate, aligning it in the correct orientation, etc. In other words, function would cease even though the enzyme would be bound to the substrate.

CHAPTER 6 Microbial Nutrition and Growth

Multiple Choice

1. D	6. D	11. B	16. B
2. B	7. B	12. D	17. C
3. A	8. D	13. A	18. A
4. C	9. D	14. D	
5. C	10. D	15. B	

Fill in the Blanks

1. nutrients
2. do, *E. coli*
3. nitrogen fixation
4. psychrophiles, 45
5. acidophiles
6. broth, colonies
7. streak plate
8. enrichment
9. 6300+
10. turbidity, indirect

Short-Answer Questions for Thought and Review

1. A limiting nutrient is one that can inhibit metabolism if it is not present. Hydrogen is not a limiting nutrient. It is the most common chemical element in cells, and metabolism is never interrupted by a lack of hydrogen.
2. Aerotolerant and microaerophilic microbes have some of the enzymes needed to protect them from reactive oxygen species, but either not all of them or they are present in too low of amounts to be completely protective against atmospheric levels of oxygen. Low oxygen levels, however, can be accommodated.
3. Tolerant is better because it means you can survive with or without the environmental factor being there. If there is no acid, you are just as capable of surviving as if there are moderate levels of acid. Obligates are much more restricted in that they actively require the condition to be there (and will die if it is not).
4. Antacids make the digestive tract more alkaline and *H. pylori* prefers alkaline conditions. Thus you are creating a favorable environment for their growth.
5. Contamination can occur during collection (microbes from other body areas), during transport (incorrect storage or contaminated supplies), or during inoculation of media at the lab (poor aseptic technique).

Critical Thinking

1. Carbon is a structural element as well as a nutritional element used to run metabolism. It is therefore needed in great quantities because it is used so much. Iron is used primarily in electron transport chains; it is critical to survival but present only in a small subset of proteins in the overall cell.
2. The concentration of the solution added to lyse the red blood cells should have a lower concentration of NaCl. This would be a hypotonic solution. This will cause water to move into the red blood cells. The result is that the cells will swell due to the increase in fluid and burst.
3. Fastidious organisms require many specific nutrients at specific levels. Few places in the environment are so specific. A human body, however, would be a perfect home for a fastidious organism, because we ourselves require nutrients in very specific levels.

Concept Building Questions

1. The most obvious effect of limiting nutrients is a decrease in metabolism; without nutrients to bring into the cell, there is nothing to fuel catabolism and without catabolism, anabolism does not occur (thus no metabolism). A more subtle effect is seen with transport mechanisms. As one nutrient becomes limiting many microbes have the ability to use others. This, however, requires the switch from one type of transporter to another in most cases. Thus, the flux in nutrients requires the cell to make many different changes to the proteins it expresses. This ultimately uses energy, and puts a bigger demand on metabolism to produce it.
2. Cold-loving organisms must have adaptations to their membranes and enzymes to maintain form and function. Membranes must be kept fluid, and one way to do this is to increase unsaturated fatty acids to disrupt hydrophobic associations within the lipids. You would also probably see weaker bonds holding molecules together; the weaker the bonds the less

energy required for movement, reaction, etc., thus an increase in the likelihood of reactivity. Enzymes would also probably be more flexible, with fewer bonds overall again to encourage movement and reactivity.

3. Many colonies can have similar morphologies and not be related. While some bacteria produce very distinctive colonies that are readily identifiable, most don't, and so morphology alone cannot be used for the majority of microbes. As we learned in Chapter 4, several tests are generally necessary to truly establish the identity of an organism. In this case, colony morphology, coupled with microscopy and metabolic tests, would be far more useful than colony morphology alone.