II. BACTERIAL GROWTH AND MICROBIAL METABOLISM

B. Bacterial Growth

LEARNING OBJECTIVES FOR THIS SECTION

1. Define the following:

a. binary fission

b. generation time

c. geometric progression

Bacterial Growth

Bacteria replicate by **binary fission** *(def)*, a process by which one bacterium splits into two. Therefore, bacteria increase their numbers by geometric progression. **Geometric progression***(def)* refers to the population of bacteria doubling every generation time as a result of dividing by binary fission.

Generation time *(def)* is the time it takes for a **population of bacteria to double in number**. For many common bacteria, the generation time is quite short, 20-60 minutes under optimum conditions. For most common pathogens in the body, the generation time is probably closer to 5-10 hours. Because bacteria grow by geometric progression and most have a short generation time, they can astronomically increase their number in a short period of time.

The relationship between the number of bacteria in a population at a given time (N_t), the original number of bacterial cells in the population (N_o), and the number of divisions those bacteria have undergone during that time (n) can be expressed by the following equation:

$$N_t = N_o \times 2^n$$

For example, Escheichia coli, under optimum conditions, has a generation time of 20 minutes. If one started with only 10 *E. coli* (N_o = 10) and allowed them to grow for 12 hours (n = 36; with a generation time of 20 minutes they would divide 3 times in one hour and 36 times in 12 hours), then plugging the numbers in the formula, the number of bacteria after 12 hours (N_t) would be

$$10 \text{ X } 2^{36} = N_t = 687{,}194{,}767{,}360 \textit{ E. coli}$$

Bacteria divide by **binary fission** wherein one bacterium splits into two. Therefore, bacteria increase their numbers by **geometric progression** whereby their population doubles every generation time.

In general, it is thought that during DNA replication (discussed in Unit 4), each strand of the replicating bacterial DNA attaches to proteins at what will become the cell division plane. As the bacterium grows to full size, the newly replicated chromosomes become separated.

In the center of the bacterium, a group of proteins called **Fts proteins interact to form a ring at the cell division plane**. These proteins **form the cell division apparatus known as the divisome**. Proteins at the divisome are thought to **synthesize the peptidoglycan and new membrane material that both splits the bacterium into two daughter cells and subsequently enables each to grow to full size**.