Example of Evolution

Antibiotic Resistance in Bacteria

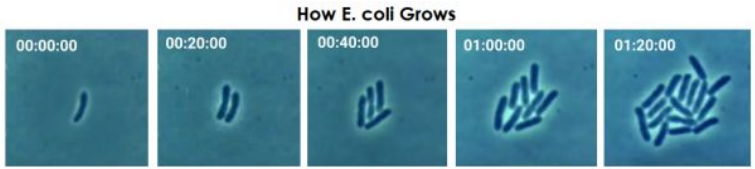
Write the highlighted information into your notes.

The Zone of inhibition is a circular area around the spot of the antibiotic in which the bacteria colonies do not grow. If bacteria are growing next to the disc of antibiotic, it means they are “resistant” to the chemical.

Objective: Outline the effect of antibiotics on development of antibiotic resistance in bacteria.

Overproduction of Offspring

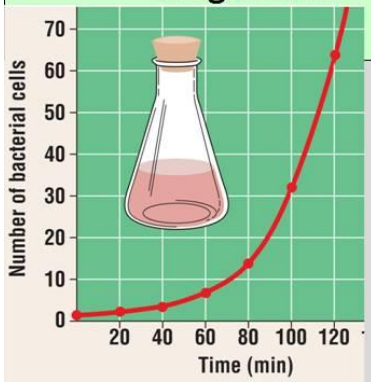
Bacteria, such as E. coli, divide by binary fission. Under ideal conditions, a single bacteria cell will divide every 20 minutes, producing far more daughter cells than could possibly survive.



E. coli (*Escherichia coli*) is a type of bacteria that lives in the digestive tracts of humans and animals. It grows by splitting in half, through a process called binary fission.

Figure 18.17a

In 24 hrs, the bacteria will comprise $2^{72} = 5 \times 10^{21}$ cells and will occupy a volume of 38,000 m^3, equal to 15 Olympic swimming pools! From a single cell!

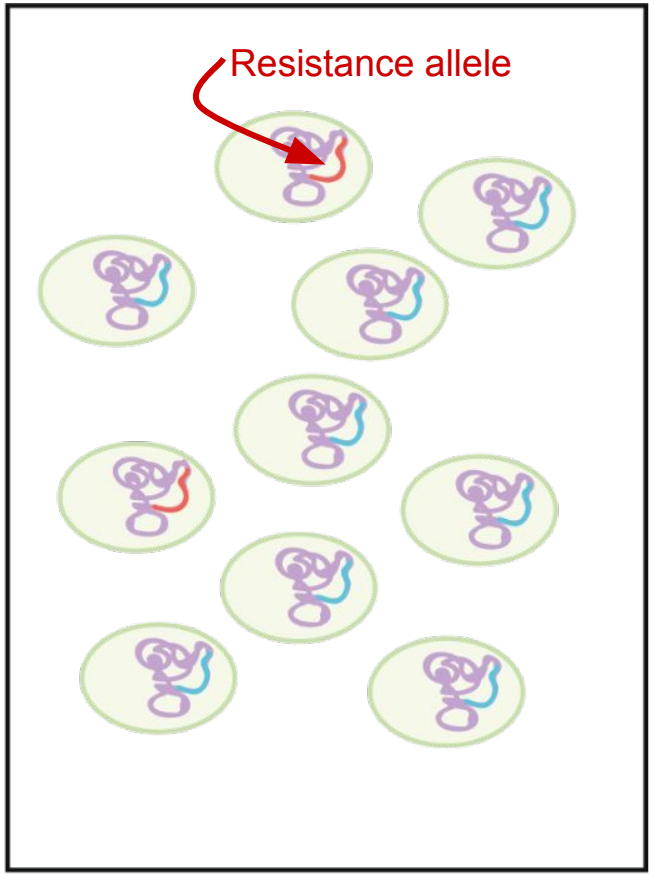


Time	Number of Cells	
0 minutes	1	$= 2^0$
20	2	$= 2^1$
40	4	$= 2^2$
60	8	$= 2^3$
80	16	$= 2^4$
100	32	$= 2^5$
120 (= 2 hours)	64	$= 2^6$
3 hours	512	$= 2^9$
4 hours	4096	$= 2^{12}$
8 hours	16,777,216	$= 2^{24}$
12 hours	68,719,476,736	$= 2^{36}$

(a) Exponential growth.

Genetic Variation

With some many offspring, there is opportunity for lots of variation between individuals. In bacteria, variation is due to mutation or gene flow (bacteria don't do meiosis or sexual reproduction). This results in some variants having an antibiotic resistance allele while others do not.



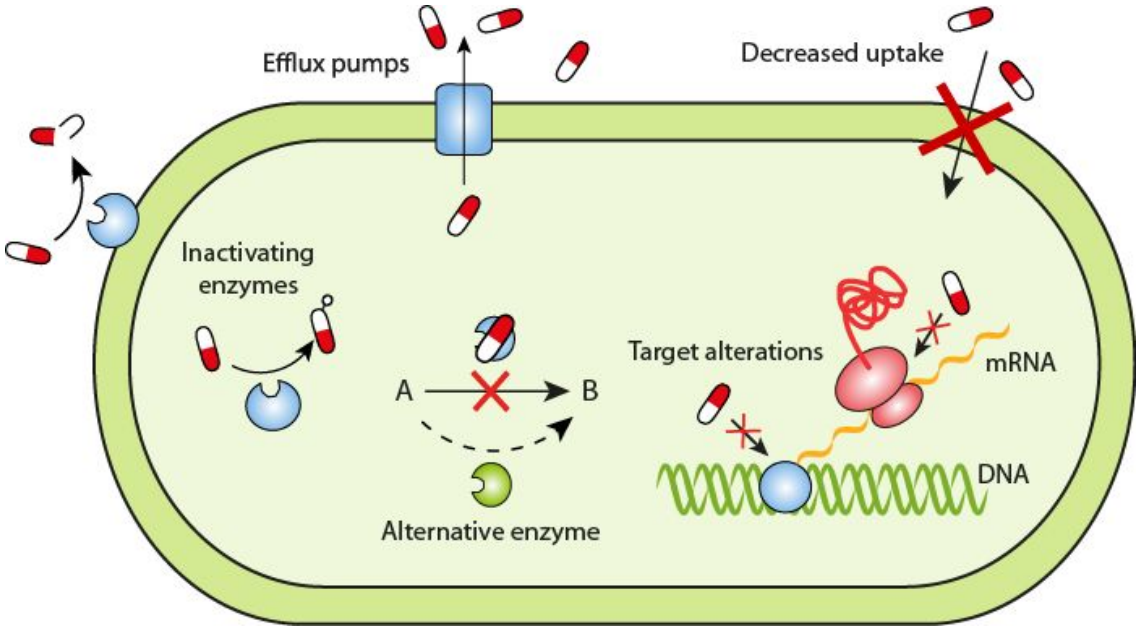
Antibiotic-resistant allele is rare
Non-resistant allele is common

Selective Pressure

Antibiotics are are medications that kill or slow down the reproduction of non-resistant bacteria.

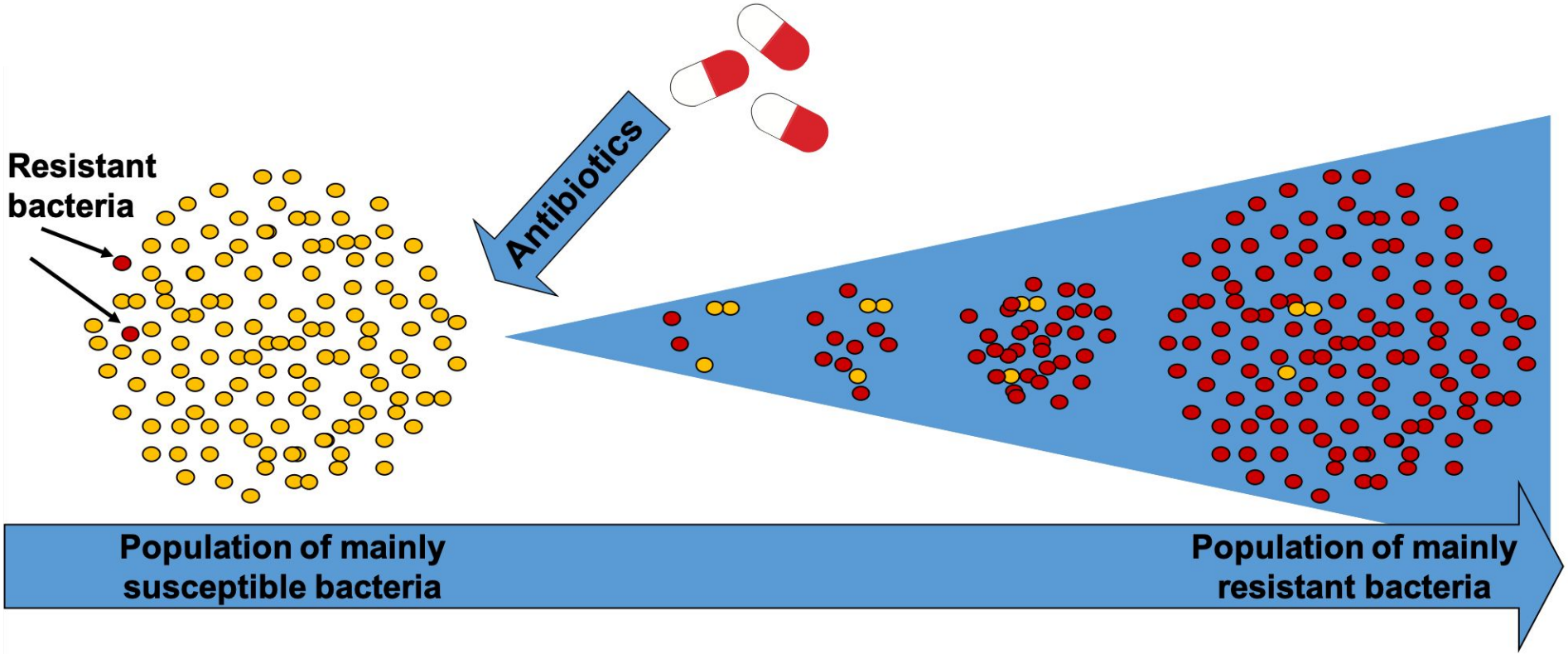
Differential Survival and Reproduction

Bacteria that have the resistance allele are able to prevent the antibiotic from entering the cell, pump the antibiotic out of the cell or inactivate the antibiotic within the cell. This allows the resistant variants to survive and continue to reproduce even in the presence of the antibiotic.



Change in the Population

Each new generation will contain more bacteria offspring from individuals with the resistance alleles, changing the population over time.



The following slides are

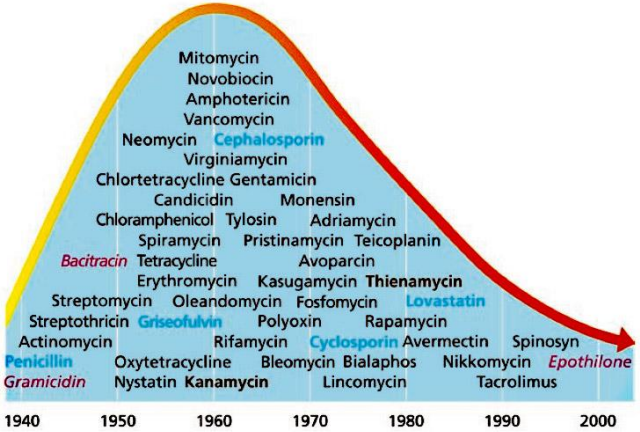
FYI

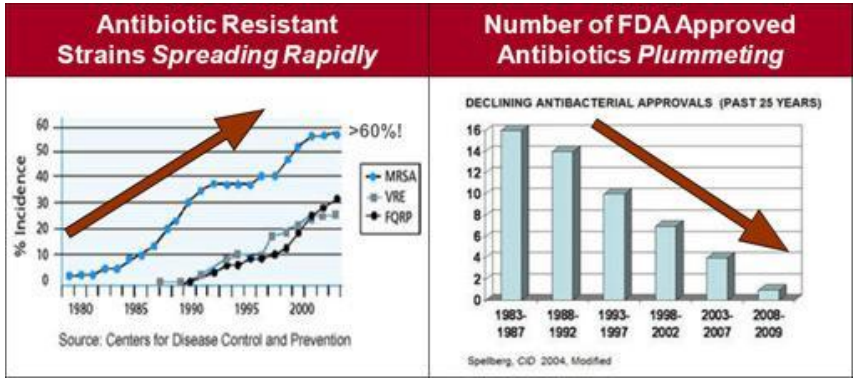
Why is resistance on the rise?

- Antibiotics are overprescribed by doctors, for example to treat illnesses that are not caused by bacteria.
- Livestock are given antibiotics to increase growth. 90% of antibiotics used are given to livestock. Many times these antibiotics come out in their waste with resistant bacteria.

Why is resistance on the rise?

- Antibiotics are not being produced by pharmaceutical companies at the rate they once were.
- This is due to there being a lack of new antimicrobial compounds that are being discovered/created.
- It is also due to the fact that antibiotics are not as good at making money as drugs that treat chronic conditions (which is why we see so many types of drugs for hearts disease, erectile dysfunction, etc…)





What can you do?

- When using an antibiotic, complete the full treatment, even after symptoms lessen (unless there are complications).
- As a patient, do not request, and as a doctor, do not prescribe, antibiotics in response to a cold, flu, or other viral illnesses. This simply increases selection for resistant bacteria and does not affect the virus.
- Use antibiotic ointments on cuts and abrasions, but avoid antimicrobial hand creams, soaps, and laundry detergents.
- Reduce the use of antibiotics in cattle feed and as sprays on fruit trees.