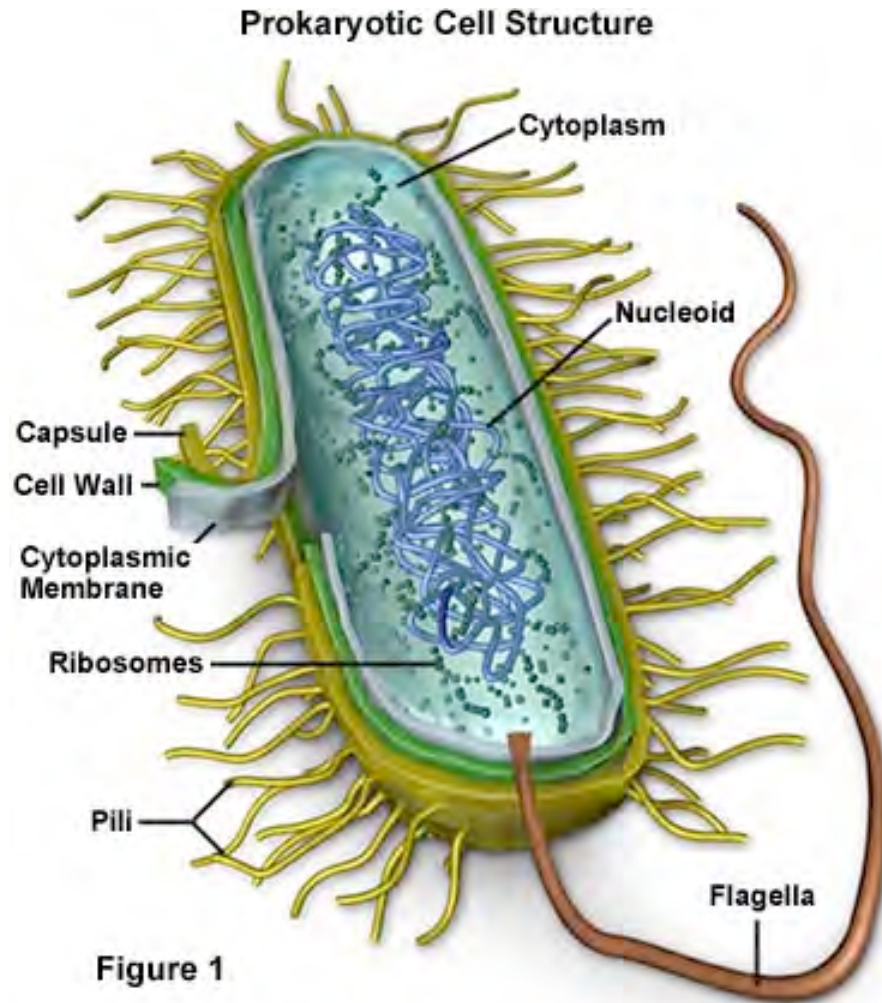


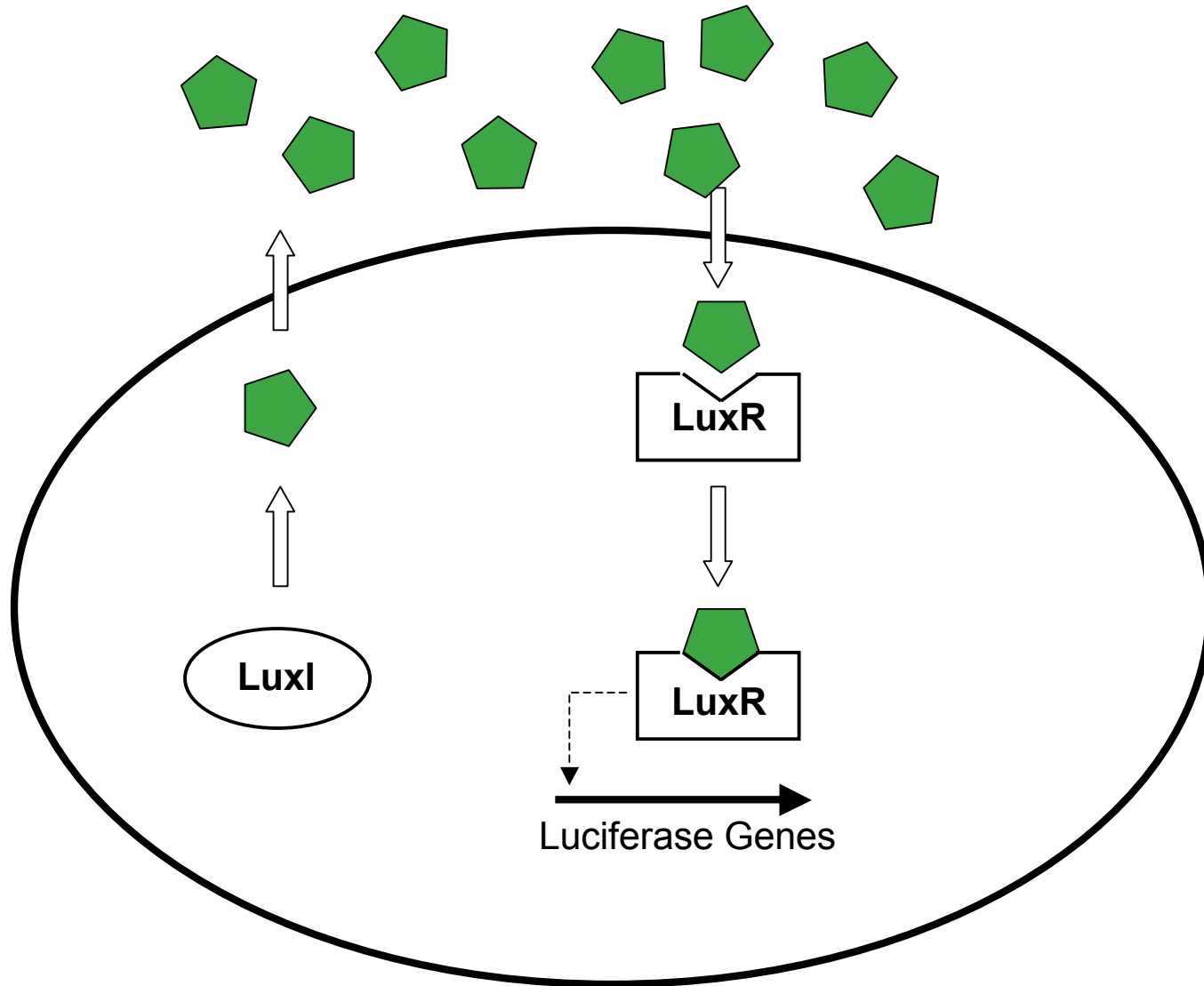
**Small Talk**  
**Cell-to-Cell Communication**  
**in Bacteria**

# Prokaryotic (Bacterial) Cells

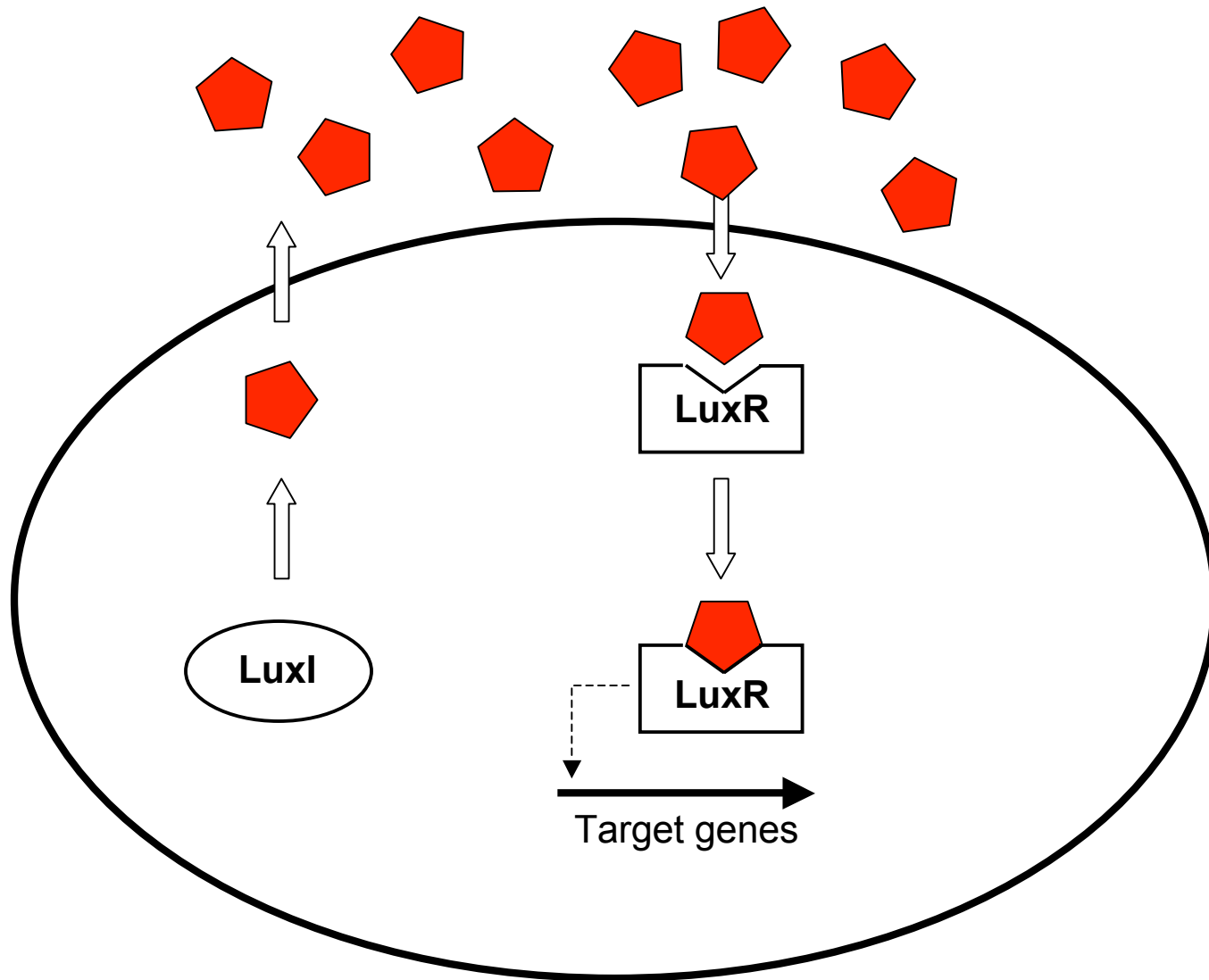




# *V. fischeri* Quorum Sensing

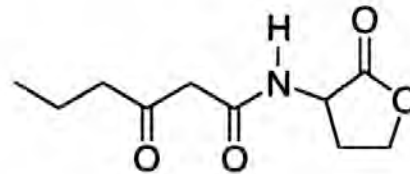


# Quorum Sensing In Bacteria

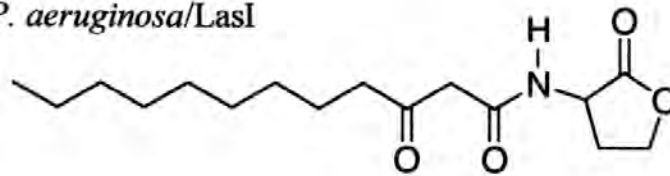


# Acyl-Homoserine Lactone Autoinducers

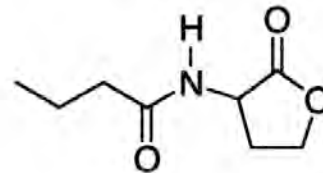
*V. fischeri*/LuxI



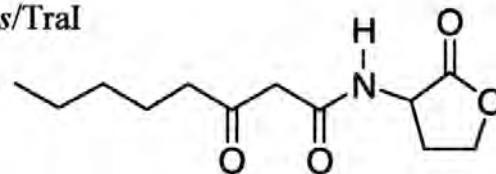
*P. aeruginosa*/LasI



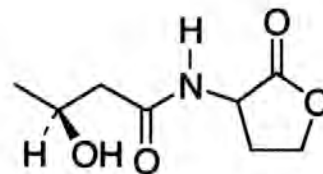
*P. aeruginosa*/RhlI



*A. tumefaciens*/TraI



*V. harveyi*/LuxLM



# LuxI-LuxR Quorum Sensing Systems

*V. fischeri*      Bioluminescence

*P. aeruginosa*      Virulence Factors, Biofilms

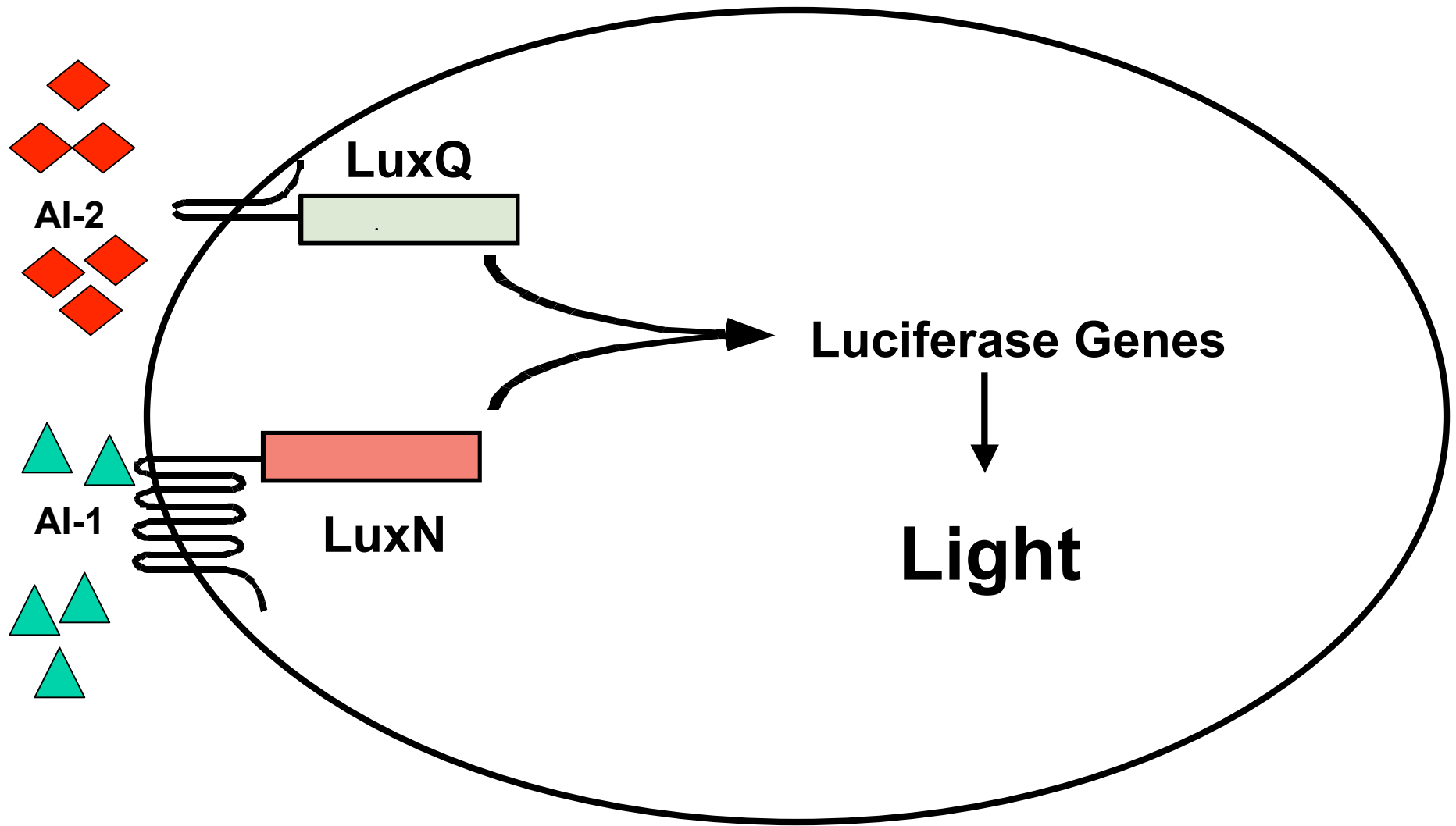
*A. tumefaciens*      Mating, Transfer of Mobile DNA

*E. carotovora*      Virulence Factors, Antibiotic  
Synthesis

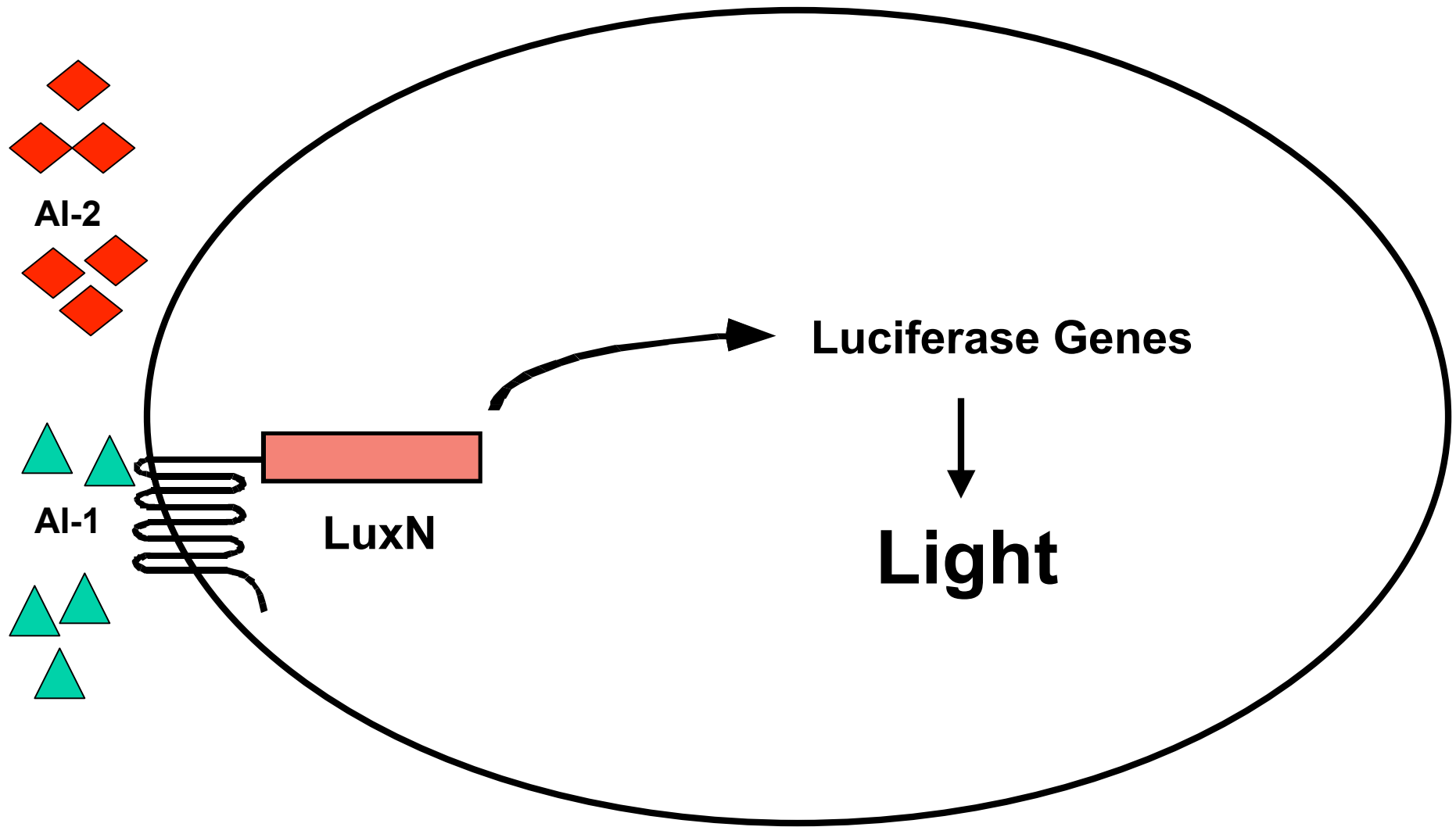




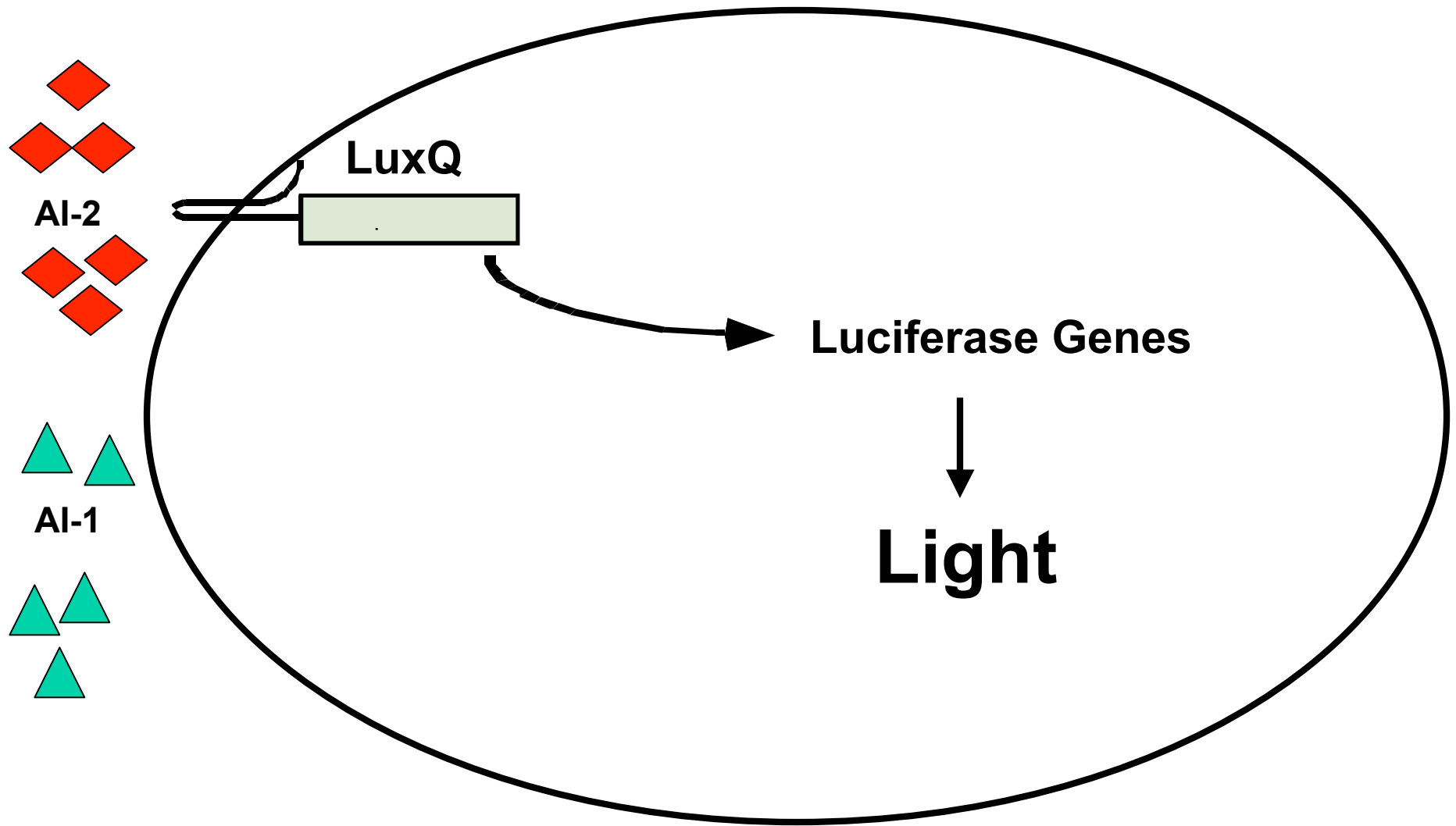
# Quorum Sensing in *V. harveyi*



# *V. harveyi* Reporter Strain AI-1



# *V. harveyi* Reporter Strain AI-2



# Bacteria That Contain *luxS*

(A sample of 534 genomes sequenced)

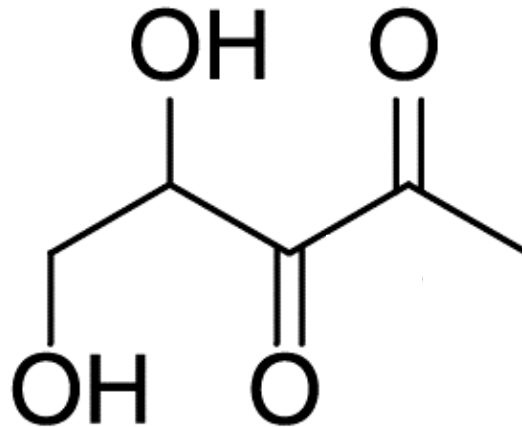
<i>Actinobacillus actinomycetemcomitans</i>	<i>Neisseria gonorrhoeae</i>
<i>Actinobacillus pleuropneumoniae</i>	<i>Neisseria meningitidis</i>
<i>Actinobacillus suis</i>	<i>Pasteurella multocida</i>
<i>Bacillus anthracis</i>	<i>Pasteurella trehalosi</i>
<i>Bacillus halodurans</i>	<i>Porphyromonas gingivalis</i>
<i>Bacillus subtilis</i>	<i>Proteus mirabilis</i>
<i>Borrelia burgdorferi</i>	<i>Salmonella paratyphi</i>
<i>Campylobacter jejuni</i>	<i>Salmonella typhi</i>
<i>Clostridium acetobutylicum</i>	<i>Salmonella typhimurium</i>
<i>Clostridium difficile</i>	<i>Shewanella putrefaciens</i>
<i>Clostridium perfringens</i>	<i>Shigella flexneri</i>
<i>Deinococcus radiodurans</i>	<i>Staphylococcus aureus</i>
<i>Escherichia coli</i> MG1655	<i>Staphylococcus epidermidis</i>
<i>Escherichia coli</i> O157:H7	<i>Streptococcus gordonii</i>
<i>Enterococcus faecalis</i>	<i>Streptococcus mutans</i>
<i>Haemophilus influenzae</i>	<i>Streptococcus pneumoniae</i>
<i>Helicobacter pylori</i>	<i>Streptococcus pyogenes</i>
<i>Klebsiella pneumoniae</i>	<i>Vibrio cholerae</i>
<i>Lactococcus lactis</i>	<i>Vibrio harveyi</i>
<i>Leuconostoc oenos</i>	<i>Vibrio parahaemolyticus</i>
<i>Listeria monocytogenes</i>	<i>Vibrio anguillarum</i>
<i>Mannheimia haemolytica</i>	<i>Vibrio vulnificus</i>
	<i>Yersinia pestis</i>

# Targets of AI-2

<i>Actinobacillus actinomycetemcomitans</i>	Periodontal virulence, Mixed-species biofilms
<i>Bacillus anthracis</i>	Growth
<i>Bacillus cereus</i>	Biofilms
<i>Bacillus subtilis</i>	Development
<i>Borrelia burgdorferi</i>	Virulence
<i>Campylobacter jejuni</i>	Motility, Toxins
<i>Clostridium difficile</i>	Virulence, Toxins
<i>Clostridium perfringens</i>	Virulence, Toxins
<i>Escherichia coli</i> K12	AI-2 transport, Biofilms, Cell division, DNA processing, Iron uptake
<i>Escherichia coli</i> EHEC O157:H7	Virulence, Type III Secretion , Motility
<i>Escherichia coli</i> EPEC	Motility, Type III Secretion
<i>Haemophilus influenzae</i>	Virulence, Cell invasion
<i>Helicobacter pylori</i>	Motility, Biofilms
<i>Klebsiella pneumoniae</i>	Biofilms
<i>Lactobacillus reuteri</i>	Biofilms in mice
<i>Listeria monocytogenes</i>	Biofilms
<i>Mannheimia haemolytica</i>	Virulence, Encapsulation, Adhesion
<i>Neisseria meningitidis</i>	Virulence, Bacteremia
<i>Photobacterium luminescens</i>	Antibiotic production
<i>Porphyromonas gingivalis</i>	Virulence, Proteases Hemin acquisition, Stress response
<i>Salmonella typhi</i>	Biofilms
<i>Salmonella typhimurium</i>	AI-2 transport, Biofilms
<i>Serratia marcescens</i>	Virulence in <i>C. elegans</i> , Hemolysin, Antibiotic production
<i>Shigella flexneri</i>	VirB (virulence factor)
<i>Staphylococcus epidermidis</i>	Virulence, Biofilms
<i>Streptococcus gordonii</i>	Mixed-species biofilms
<i>Streptococcus mutans</i>	Virulence, Biofilms, Competence, Stress response
<i>Streptococcus pneumoniae</i>	Virulence, Persistence, Competence
<i>Streptococcus pyogenes</i>	Virulence factors, Protease, Hemolysin
<i>Vibrio anguillarum</i>	Protease
<i>Vibrio cholerae</i>	Virulence, Toxins, Biofilms
<i>Vibrio fischeri</i>	Bioluminescence, Colonization
<i>Vibrio harveyi</i>	Bioluminescence, Biofilms, Siderophore, Virulence, Type III Secretion, Protease

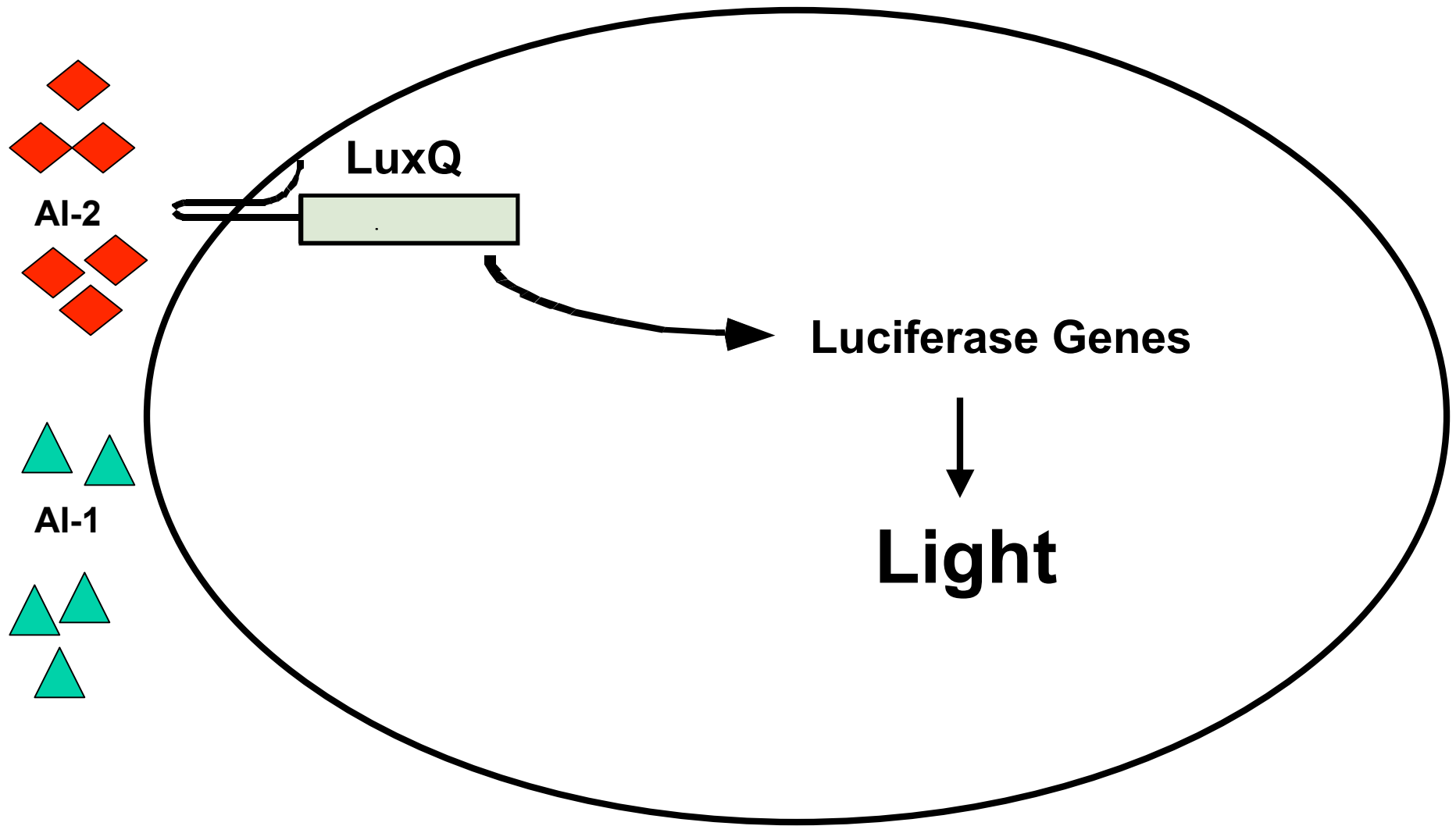
# Inter-Species Communication

## The Structure of AI-2

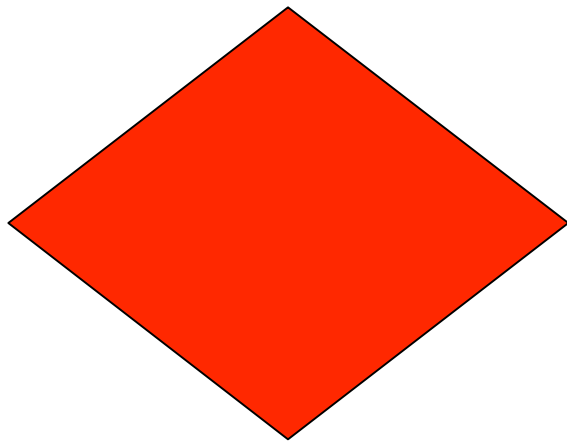


4,5-Dihydroxy-2,3-Pentanedione

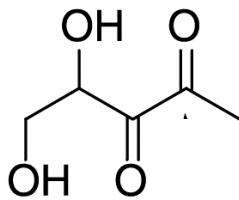
# Making Antibiotics Based on AI-2



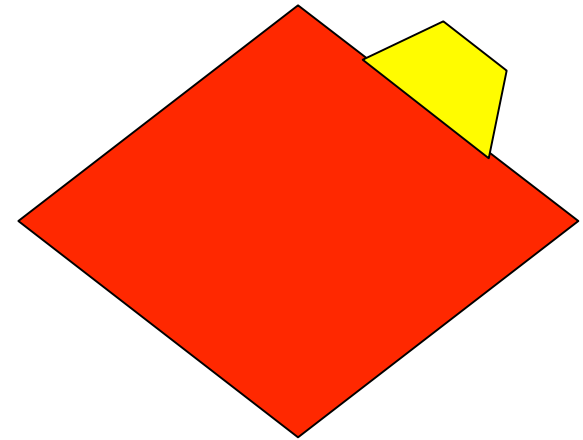
# Making Antibiotics Based on AI-2



**AI-2**



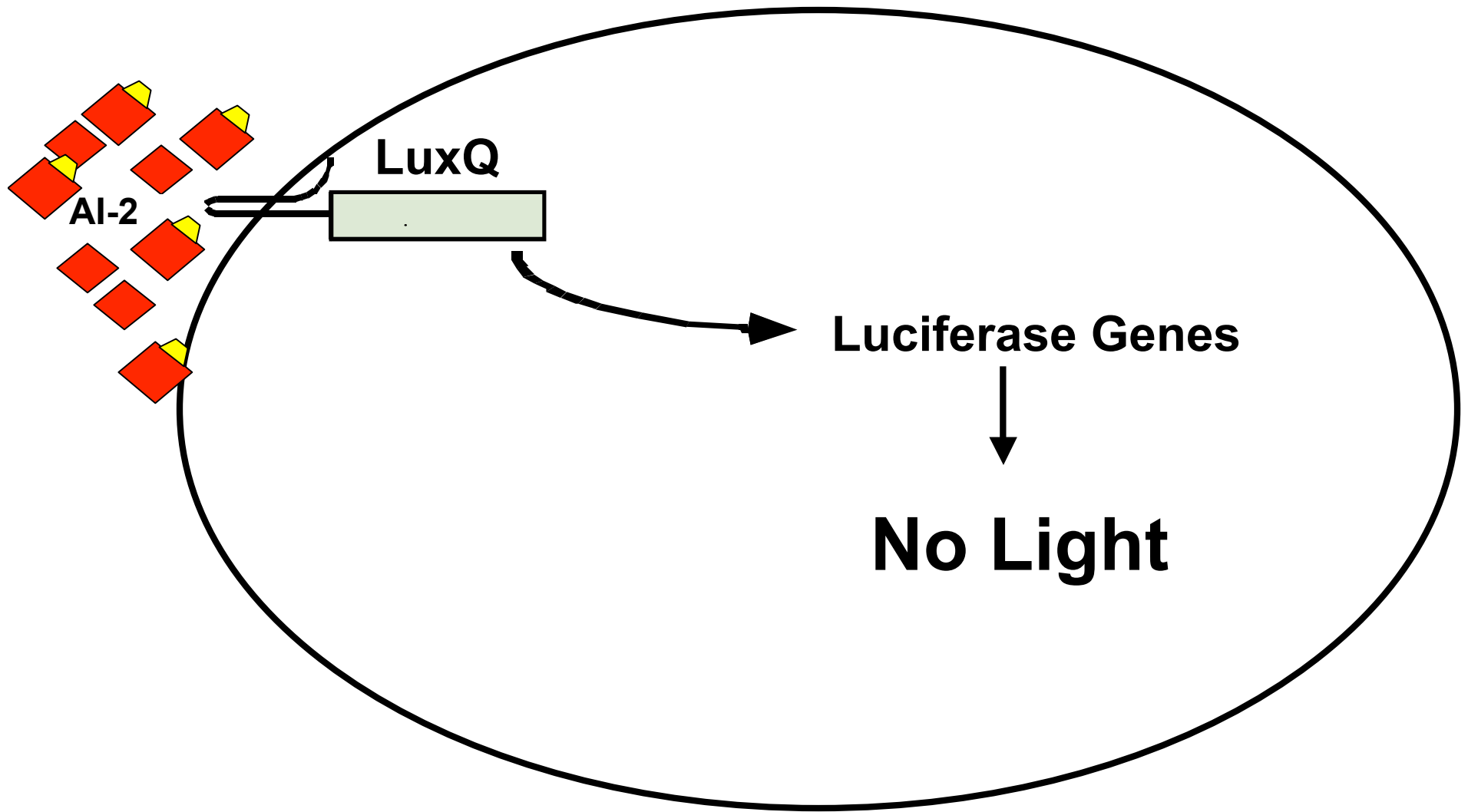
**CHEMISTRY**



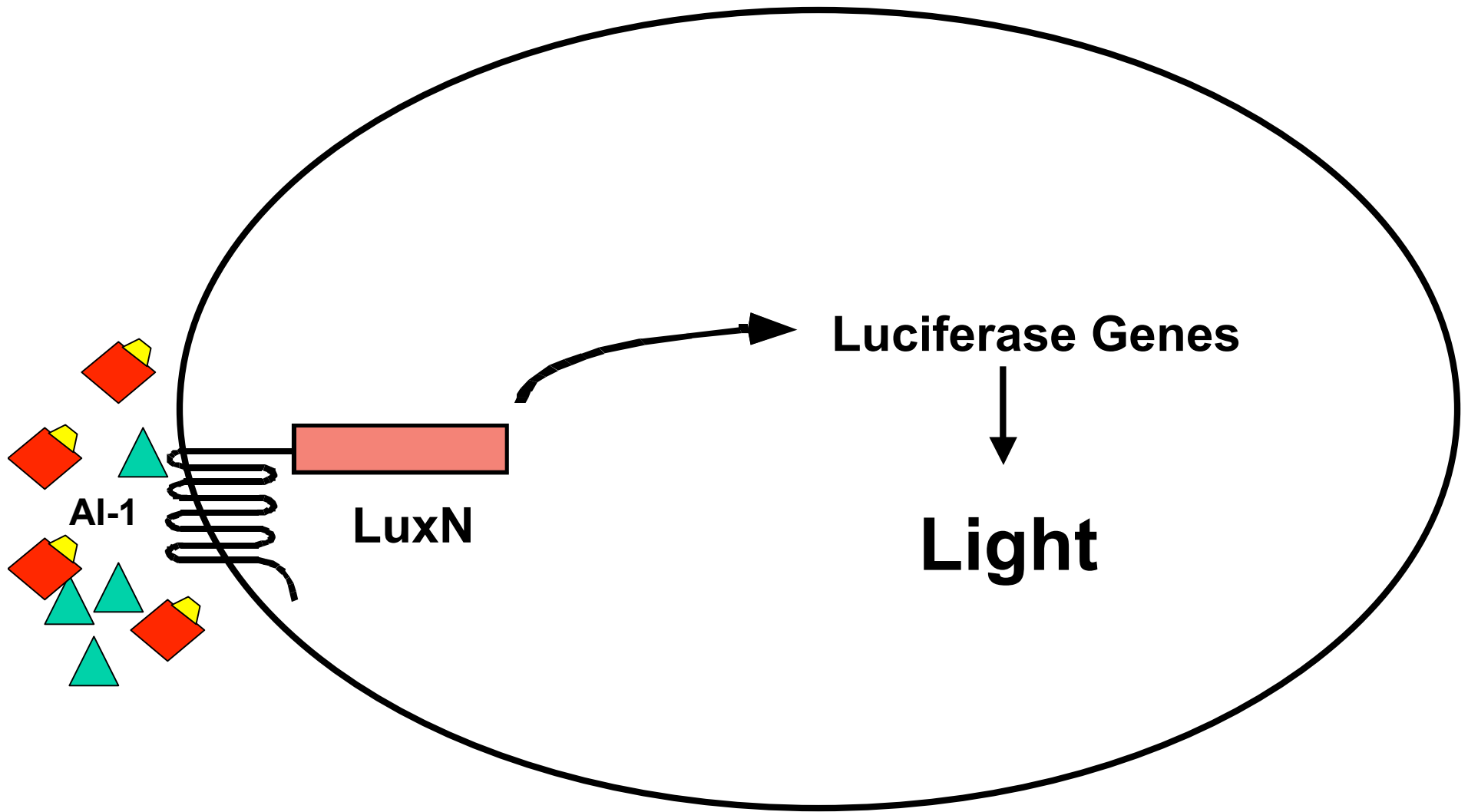
**AI-2  
Analog**



# Making Antibiotics Based on AI-2

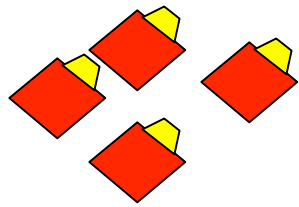


# Making Antibiotics Based on AI-2



# Making Antibiotics Based on AI-2

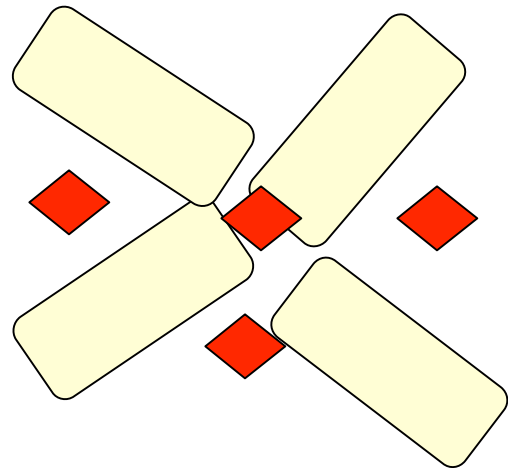
Test Substance



Feed



Dead  
or  
Alive



Virulent Bacteria

# Quorum Sensing In Bacteria

Bacteria Talk to Each Other

*Multiple Languages  
i.e., intra- and inter-species communication*

Bacteria Distinguish Self from Other

*Many More Molecules Remain To Be Discovered  
i.e., molecules that tell “who” the other is*

Quorum Sensing Allows Bacteria To Be Multi-Cellular  
Similar to Higher Organisms

*Opportunities for Novel Biotechnological Applications To  
Impede/Enhance Quorum Sensing Controlled Functions*

Natural Anti-Quorum Sensing Strategies Already Exist

