Game summary:

In Build a Bacterium, the goal of the game is to reach the Nobel prize in Physiology or Medicine at the centre of the board. To accomplish this, players aim to collect plasmids and signalling proteins for their bacterium each of which will improve the chances of surviving and reaching the centre first!

Components:

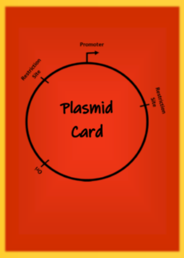
31 plasmid cards

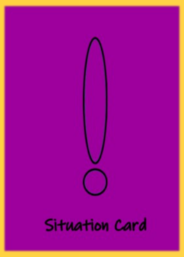
24 situation cards

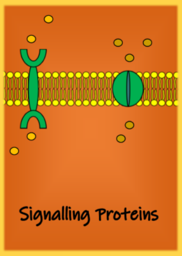
11 signalling cards

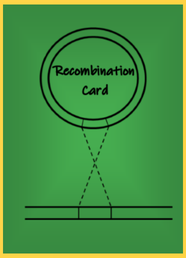
10 recombination cards

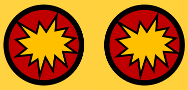
30 ATP tokens











Game set up:

1. Shuffle and separate the plasmid, signalling protein and situation cards into their own decks and place them face down in the board game area
2. Place all the ATP tokens in a pile next to the decks of cards
3. Allow each player to pick their bacterium's colour, this will be the game piece that is moved around the board, place all these pieces on the START space

Basic game play:

1. Build your own bacterium is played in rounds, the youngest player starts. Roll the dice and moves their bacterium the same number of spaces, play continues clockwise.
2. The player should then pick up the card that corresponds to the colour space they landed on, read the card:

    - On **green** spaces, pick up a recombination event card and one ATP (however as bacteria gain plasmids, they may be able to pick up more). These can be left in a pile the table in front of the player.

    - On **red** spaces, pick up a plasmid card. Your bacterium now contains that plasmid and possesses its features however if a player wants to make sure that plasmid is not lost or stolen it needs to be recombined into their bacterium's chromosome. Players should keep unintegrated plasmids in their hands, however integrated plasmids can be placed face up on the table in front of the player

    - On **purple** spaces, pick up the situation card. Read and perform the action as described on the card then replace the card to the bottom of pack.

3. Play finishes when a player's bacterium reaches the Nobel prize at the centre of the board

The finer points:

- The green recombination cards can be traded in with 2 ATP when a player wants to integrate a plasmid into their bacterium's chromosome.

- If a player moves to a different space as the result of the actions of a situation card, they should not play the new space they have just landed on, including when a player moves through ion channels.

- If a player picks up a plasmid card or a signalling protein that they already have and do not wish to keep, they may trade it back into the pile in exchange for 1 ATP token.

- If a player is on the outer layer and wishes to activity transport to the next inner layer, they can pay 5 ATP and move to the first space of the next ring

Glossary

Anaerobic Conditions

This is an environmental condition that lacks oxygen. Only some bacteria can survive these conditions if they have specific coping methods such as the FNR sensory protein.

Antibiotic

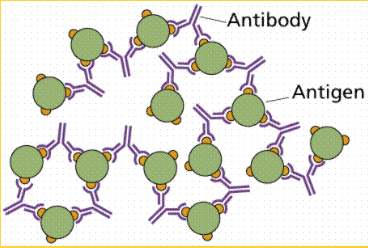
This is any substance that activity prevents bacterial growth, therefore they are useful in fighting bacterial infections.

Antibiotic resistance

This is an ability that some bacteria possess that allows them to withstand the effects of specific antibiotics.

Antibody

This is a specific protein that is produced by the immune system to detect and neutralise any foreign antigens that are present in the body.



Antigens

This is a type of toxin or a foreign substance that triggers an immune response in the body, including the production of antibodies.

ArcAB sensory proteins

This is a two-component sensory system in some bacteria that allows them to detect and respond to the surrounding oxygen levels, the response controls the expression of the respiration genes.

Bacteria/microorganism

These are really small, single-celled organisms that are found in a wide range of environments. Bacteria can be both good such as those found in the human gut, or bad like those that cause disease.

Beta-Lactamase

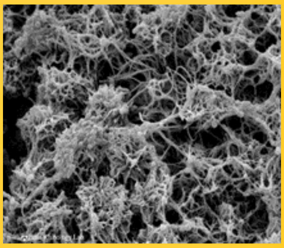
This is an enzyme that is produced by some bacteria, the enzyme prevents the effects of the beta-lactam antibiotic from working therefore making the bacteria resistant.

Beta-lactam antibiotics

These are a class of antibiotics that all contain the beta-lactam ring in their structure. These antibiotics usually work by stopping the formation of the cell wall. Some bacteria can cut these rings using the beta-lactamase enzyme stopping the antibiotic from working.

Biofilms

This is a mixture of microorganisms and bacteria which have all stuck together and to a surface. The cells embedded within the biofilm are protected from the body's immune system.



Carbohydrate

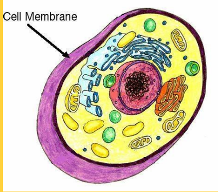
These make up a large group of organic compounds that are found in foods and living tissues. They can be broken down to release energy.

Cat-gene

This gene allows for the production of the CAT enzymes, which allow bacteria to be resistance to the effects of the chloramphenicol antibiotic.

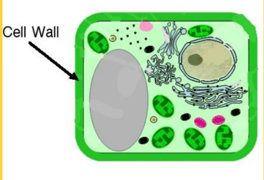
Cell membrane

This is a partially permeable membrane this which surrounds the cytoplasm of a bacterial cell.



Cell wall

This is a structural layer that surrounds some types of cells. It can be tough, flexible or rigid to provide support and protection.



CheY-FilM sensory protein

This was the first two-component system discovered. It detects the number of stimulant molecules around the bacterium and responds by control the flagella proteins (FilM), propelling the bacteria to a more nutritious areas.

Chloramphenicol

This is an antibiotic used to treat bacterial infections by stopping the bacteria's production of proteins.

Conjugation

This is the temporary union of two bacterial cells for the exchange of genetic material via pili.

Covalent bond

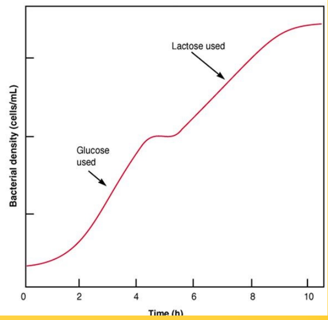
This is a type of chemical bond that involves sharing a pair of electrons.

Desiccation

This is an extreme state or process of drying out in the absence of water. Desiccation can damage a bacteria's DNA over prolonged periods.

Diauxic Growth

This is when bacteria breakdown metabolites sequentially rather than simultaneously because one metabolite is usually preferred over another one.



EnvZ-OmpR sensory proteins

This is a two-component sensory system in some bacteria that allows them to detect and respond to changes in osmotic pressure, the response controls the expression of differently sized pores in the cell membrane.

Enzyme

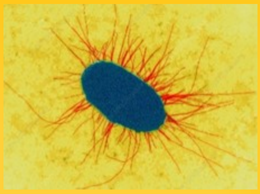
These are biological molecules that increase the speed of chemical reactions that occur in bacterial cells. They are vital to sustain life as the metabolic processes would be too slow otherwise.

FNR sensory protein

The FNR sensory protein is a one-component sensory protein that allows bacteria to detect and respond to anaerobic conditions, the response involves stopping the expression of respiratory genes.

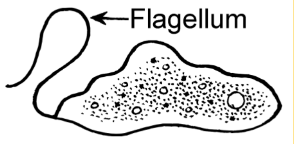
Fimbrae

These are long structures that bacteria use stick to each other and to biofilms, they can be straight or flexible.



Flagellum

This is a hair-like structure possessed by certain bacteria. It allows a bacterium to move, some bacteria can have multiple flagellum.



Gene

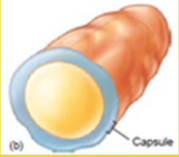
This is a sequence of nucleotides in DNA or RNA that code for a molecule that has a function.

Genetic material (DNA and RNA)

This refers to the material found in the cytoplasm of bacterial cells which determines the structure and function of the cell. The material is capable of self-replicating and changing to create genetic variation.

Glycocalyx capsule

This is a glycolipid or a glycoprotein layer covering the cell membrane of some bacteria. It consists of many membrane-bound macromolecules that serve as a backbone for support and energy reserve.



Glycolipid

This is a type of lipid (fat molecule) with a carbohydrate attached by a covalent bond. It has a role in maintaining the stability of the cell membrane.

Glycoprotein

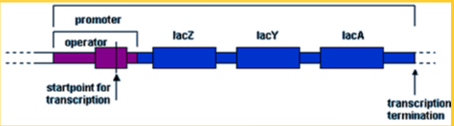
This is a type of protein which contain chains of saccharides attached by a covalent bond. They are commonly found on the cell membrane for cell-cell interactions.

Immune response against bacteria

The human's immune system can recognise and defend itself from foreign or harmful substances by responding to the antigens present on the surface of cells, viruses, fungi or bacteria.

Lac operon

This is a series of genes that are involved in the transport and breakdown of lactose. However, glucose is the preferred carbon source so diauxic growth occurs, so lactose is only used when glucose is not available.



Luciferase enzyme

This enzyme produces bioluminesce (light). The bobtail squid has a symbiotic relationship with these bioluminescent bacteria as they grow the light organ.

LuxO sensory proteins

LuxO is a protein that detects and response to the amount of quorum sensing molecules surrounding the bacterial cell.

Macromolecules

These are very large molecules usually made up of smaller subunits.

Metabolite

This is a substance which is formed in or is necessary for metabolism.

One component sensory protein

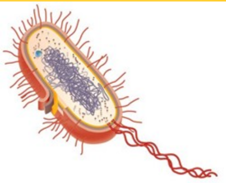
This is when the same protein can both detect and produce an appropriate response to an environmental condition.

Operon

This is a functioning unit of genomic DNA that contains a cluster of genes, usually with similar or complementary functions, under the control of a single promotor.

Osmotic lysis

This is when a bacterium is unable to control the inflow of water, therefore swells and bursts due to overinflation.

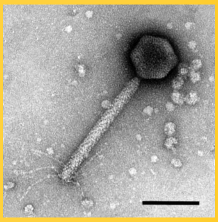


Osmotic pressure

This is the minimum pressure needed to be applied to solution surrounding a bacterial cell to prevent inward flow across the bacteria's cell membrane. Bacteria contain lots of salts, proteins and other molecules which means water is usually trying to flow inwards, this can be a problem for cells as they can undergo osmotic lysis.

Phages

These are viruses that infect and replicate within the cells of bacteria, the most basic form has a layer of proteins that surround either DNA or RNA.

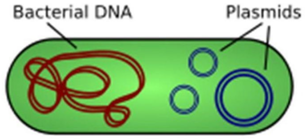


Phagocytosis

This is a bacterial process where certain bacteria can ingest or engulf other cells or large particles.

Pili

These are small hair-like structures found on the surface of bacteria used for conjugation of bacterial DNA.



Plasmid

This is a small DNA molecule within a cell that is physically separated from chromosomal DNA.

Plasmid loss

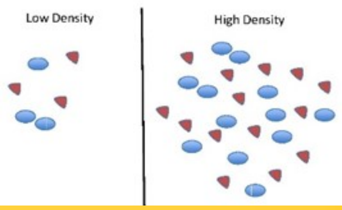
This is a naturally occur process performed by the bacteria as it replicates resulting in the loss of unintegrated plasmids.

Promotor

This is a region of DNA that initiates transcription of a particular gene.

Protein

This is a type of organic compound that contains nitrogen, it is made up of smaller subunits. The compound is essential for all living organisms.

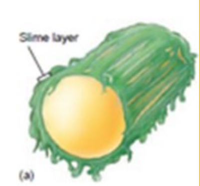


Quorum sensing

This is an ability that some bacteria possess that allows them to detect and respond to the number of other cells surrounding them.

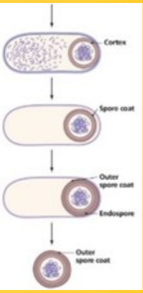
Saccharides

These are a type of carbohydrate, specifically sugar molecules that can be joined together to make a chain.



Slime layer

A layer which surrounds bacterial cells, protecting them from the environmental dangers. The layer can be non-uniform in thickness and density.

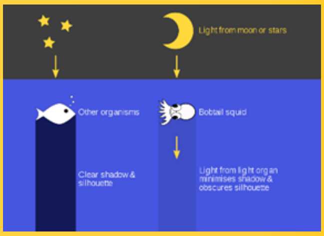


Sporulation

Sporulation is the formation of near inactive forms of bacteria, it occurs during unfavourable environmental conditions.

Symbiotic relationship

This is when two or more organisms help one another with the intent of getting help in return. For example, the Bobtail squid has a relationship with bioluminescent bacteria, the bacteria are fed by the squid and in return the squid's silhouette is hidden by the bacteria's light therefore camouflaging it from predators below.



Transcription

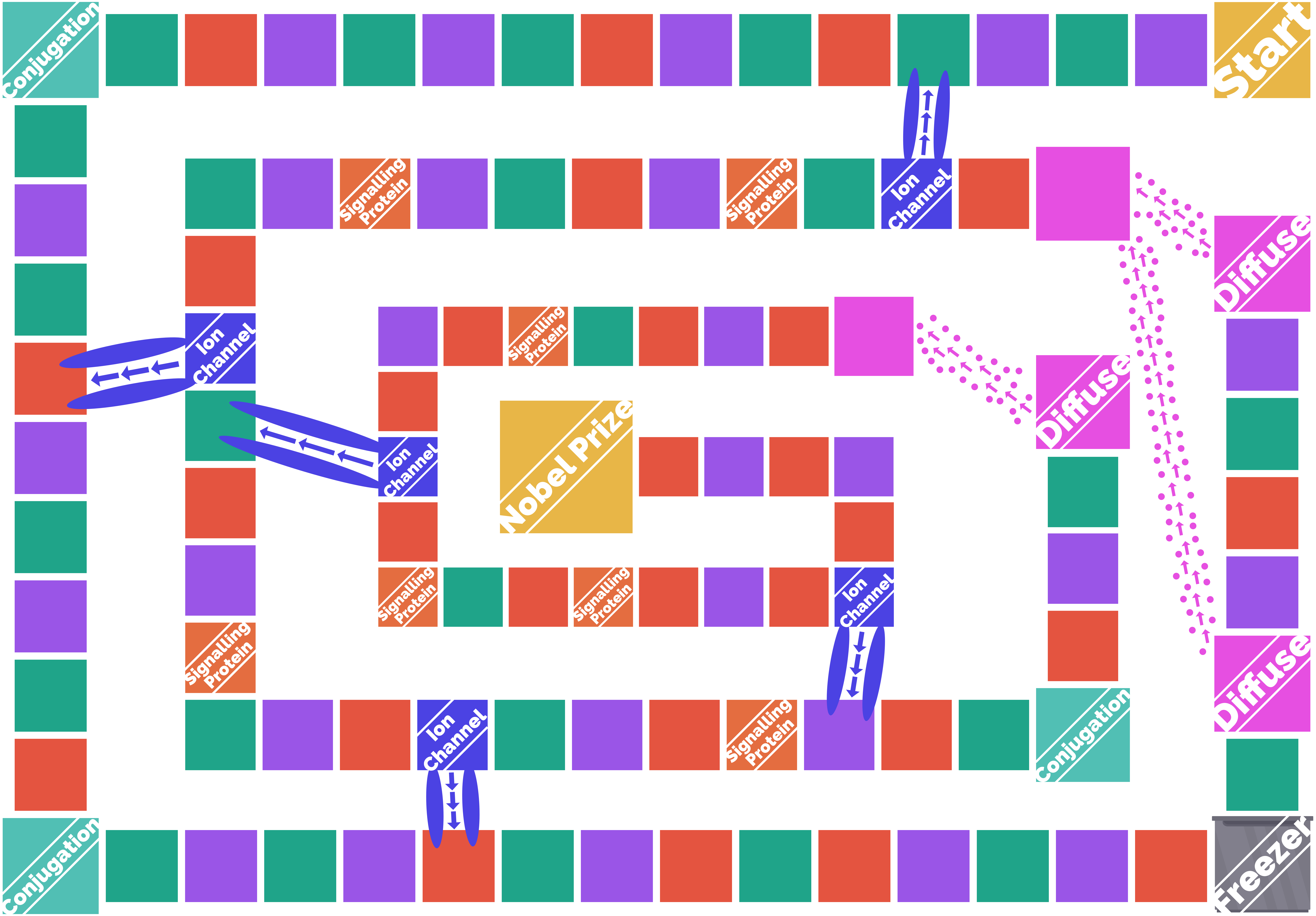
This is the first step that is required for gene expression, it requires the DNA to be copied into RNA.

Two-component sensory system

These types of systems can be very diverse, sensing many different stimuli. Typically, they allow the bacteria to sense and respond to changes in different environmental conditions.

UV radiation

Too much UV radiation from the sun can damage a bacterium's genetic material. The radiation can change the DNA bases therefore altering the proteins produced.


Conjugation
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Signalling Protein
Signalling Protein
Ion Channel
Diffuse
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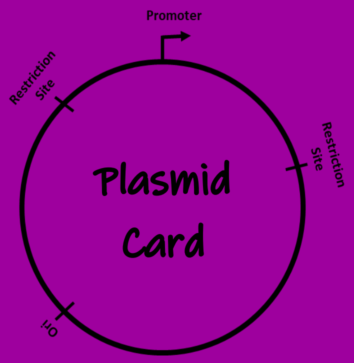
Freezer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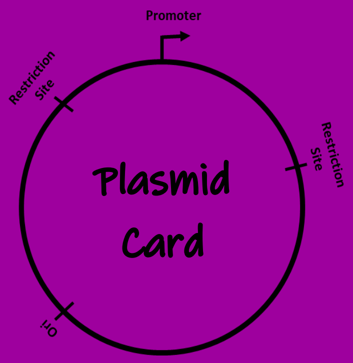
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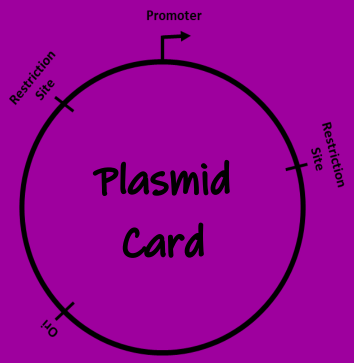
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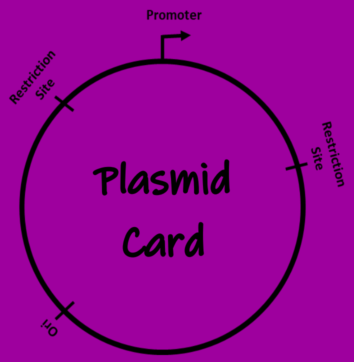
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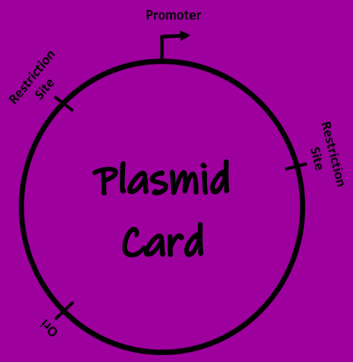
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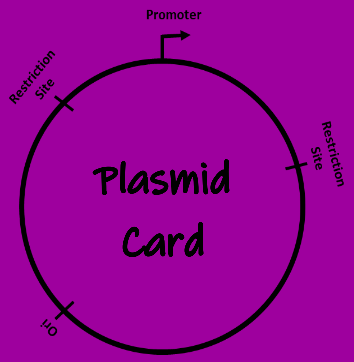
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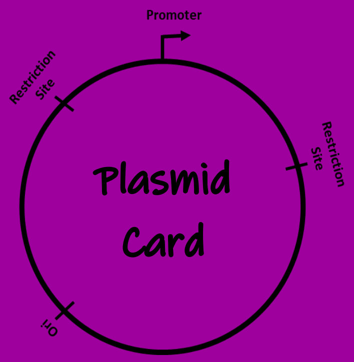
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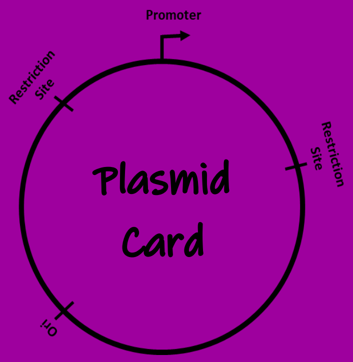
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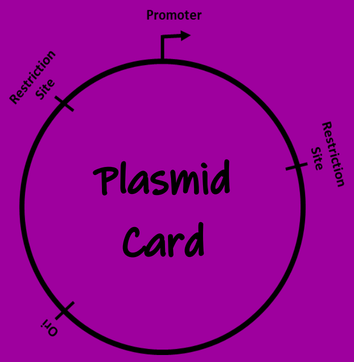
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Situation Card

Situation Card

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Situation Card


Recombination
Card


Recombination
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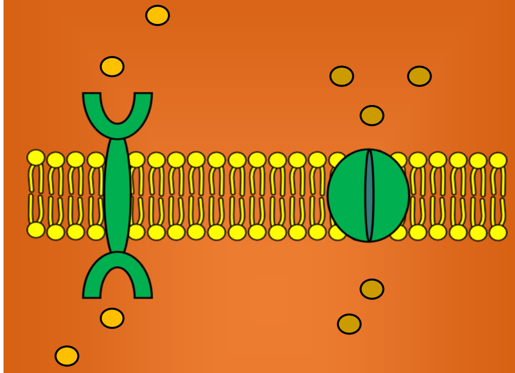
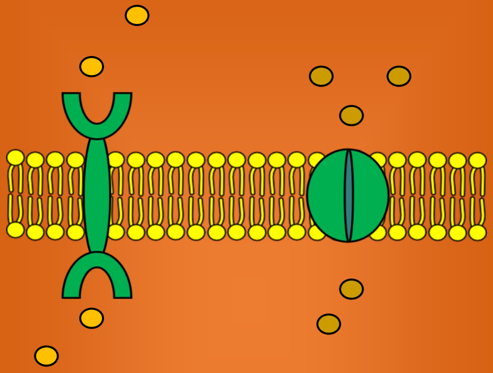
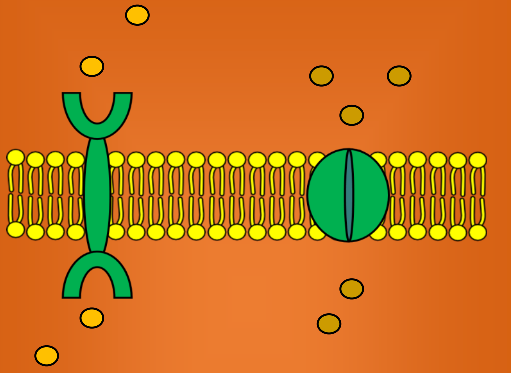


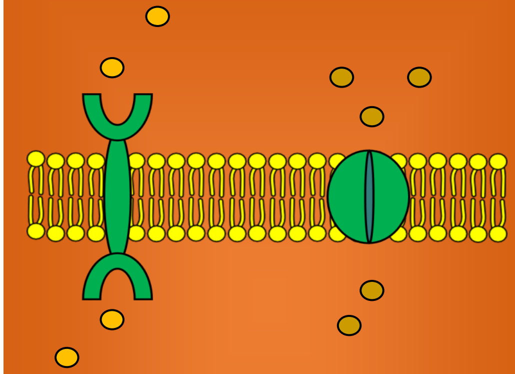
Signalling Proteins



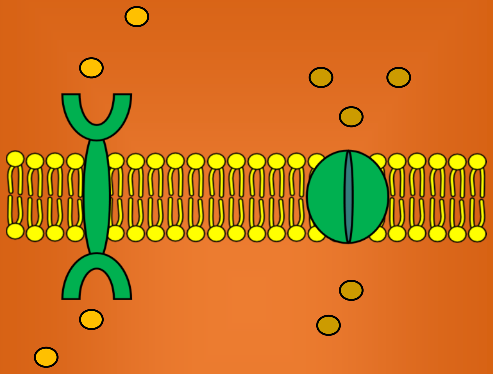
Signalling Proteins



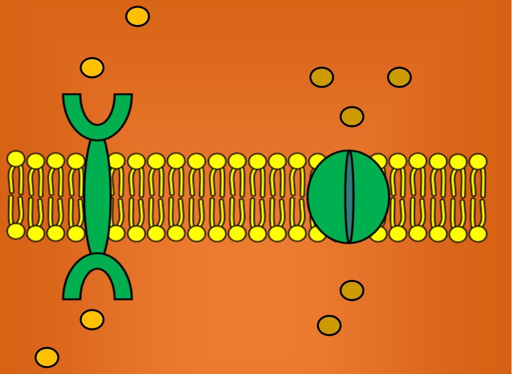
Signalling Proteins



Signalling Proteins



Signalling Proteins



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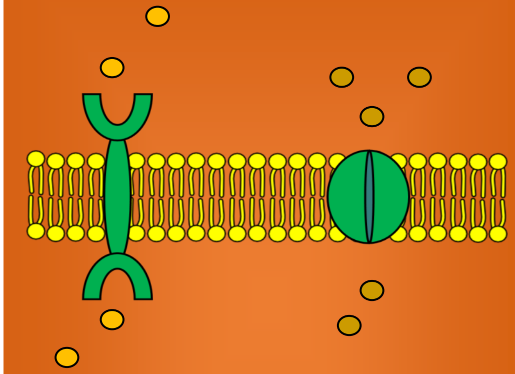

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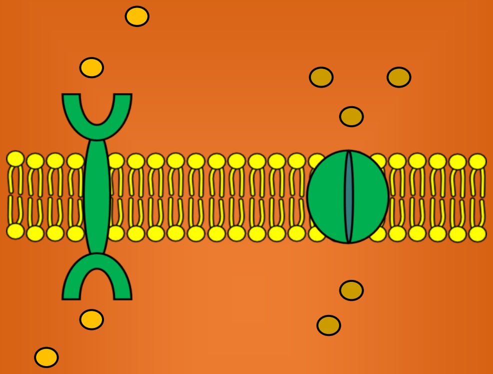
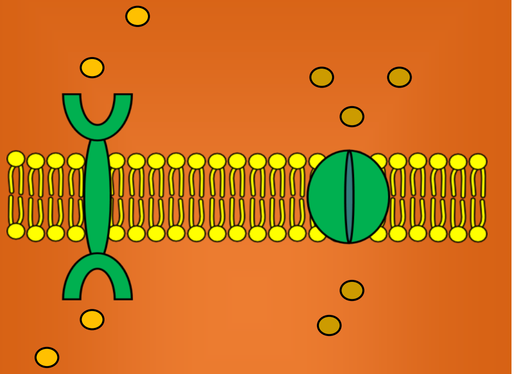


Signalling Proteins



Signalling Proteins

Eaten!

You have been ingested by an animal, unless you can sporulate, your bacterium can't survive the stomach enzymes

Go back 5 spaces

Eaten!

You have been ingested by an animal, unless you can sporulate, your bacterium can't survive the stomach enzymes

Go back 5 spaces

Eaten!

You have been ingested by an animal, unless you can sporulate, your bacterium can't survive the stomach enzymes

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Go back 5 spaces

Eaten!

You have been ingested by an animal, unless you can sporulate, your bacterium can't survive the stomach enzymes

Go back 5 spaces

Desiccation!

Unless you have the glycocalyx capsule your bacterium dries out

Go back 3 spaces

Desiccation!

Unless you have the glycocalyx capsule your bacterium dries out

Go back 3 spaces

Desiccation!

Unless you have the glycocalyx capsule your bacterium dries out

Go back 3 spaces

Desiccation!

Unless you have the glycocalyx capsule your bacterium dries out

Go back 3 spaces

Desiccation!

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Go back 3 spaces

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Go back 3 spaces

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Go back 3 spaces

Desiccation!

Unless you have the glycocalyx capsule your bacterium dries out

Go back 3 spaces

Desiccation!

Unless you have the glycocalyx capsule your bacterium dries out

Go back 3 spaces

Phagocytosis!

Unless your bacterium has a flagella, it can't escape from being engulfed by another bacterium!

Go back 5 spaces

Phagocytosis!

Unless your bacterium has a flagella, it can't escape from being engulfed by another bacterium!

Go back 5 spaces

Phagocytosis!

Unless your bacterium has a flagella, it can't escape from being engulfed by another bacterium!

Go back 5 spaces

Phagocytosis!

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Unless your bacterium has a flagella, it can't escape from being engulfed by another bacterium!

Go back 5 spaces

Chloramphenicol Environment!

You bacterium is in an environment containing chloramphenicol, unless it is resistant go to the freezer!

Chloramphenicol Environment!

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Chloramphenicol Environment!

You bacterium is in an environment containing chloramphenicol, unless it is resistant go to the freezer!

Plasmid Loss

Your bacterium undergoes a round of replication but in doing so losses all plasmids that are not chromosomal

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Your bacterium undergoes a round of replication but in doing so losses all plasmids that are not chromosomal

Nutrient Broth!

Your bacterium has found itself in a nutrient broth!

Move ahead 3 spaces

Nutrient Broth!

Your bacterium has found itself in a nutrient broth!

Move ahead 3 spaces

Nutrient Broth!

Your bacterium has found itself in a nutrient broth!

Move ahead 3 spaces

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Move ahead 3 spaces

Nutrient Broth!

Your bacterium has found itself in a nutrient broth!

Move ahead 3 spaces

Nutrient Broth!

Your bacterium has found itself in a nutrient broth!

Move ahead 3 spaces

Osmotic Shock!

Unless your bacterium has the Env-OmpR signalling proteins, it suffers from osmotic lysis!

Move back 5 spaces

Osmotic Shock!

Unless your bacterium has the Env-OmpR signalling proteins, it suffers from osmotic lysis!

Move back 5 spaces

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Osmotic Shock!

Unless your bacterium has the Env-OmpR signalling proteins, it suffers from osmotic lysis!

Move back 5 spaces

Phage Attack!

Your bacterium has been attacked by phages

Go back 10 spaces

Phage Attack!

Your bacterium has been attacked by phages

Go back 10 spaces

Phage Attack!

Your bacterium has been attacked by phages

Go back 10 spaces

Phage Attack!

Your bacterium has been attacked by phages

Go back 10 spaces

Phage Attack!

Your bacterium has been attacked by phages

Go back 10 spaces

Phage Attack!

Your bacterium has been attacked by phages

Go back 10 spaces

Phage Attack!

Your bacterium has been attacked by phages

Go back 10 spaces

Phage Attack!

Your bacterium has been attacked by phages

Go back 10 spaces

Phage Attack!

Your bacterium has been attacked by phages

Go back 10 spaces

No Oxygen!

Unless your bacterium has the FNR one-component protein, it cannot survive these anaerobic conditions

Go back 3 spaces

No Oxygen!

Unless your bacterium has the FNR one-component protein, it cannot survive these anaerobic conditions

Go back 3 spaces

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Unless your bacterium has the FNR one-component protein, it cannot survive these anaerobic conditions

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Unless your bacterium has the FNR one-component protein, it cannot survive these anaerobic conditions

Go back 3 spaces

No Oxygen!

Unless your bacterium has the FNR one-component protein, it cannot survive these anaerobic conditions

Go back 3 spaces

The Immune System!

When inside an animal, unless your bacterium has fimbriae, it is detected by the immune system and removed

Go back 3 spaces

The Immune System!

When inside an animal, unless your bacterium has fimbriae, it is detected by the immune system and removed

Go back 3 spaces

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When inside an animal, unless your bacterium has fimbriae, it is detected by the immune system and removed

Go back 3 spaces

Beta-lactam Environment!

You bacterium is in an environment containing Beta-lactam, unless it is resistant go to the freezer!

Beta-lactam Environment!

You bacterium is in an environment containing Beta-lactam, unless it is resistant go to the freezer!

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UV Light!

You bacterium is exposed to UV light; this causes a spontaneous mutation to occur

Pick up a red card

UV Light!

You bacterium is exposed to UV light; this causes a spontaneous mutation to occur

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UV Light!

You bacterium is exposed to UV light; this causes a spontaneous mutation to occur

Pick up a red card

Luciferase Enzyme

This allows your bacterium to bioluminesce, gaining you a symbiotic relationship

Pick up an extra ATP each time you land on a green space

Luciferase Enzyme

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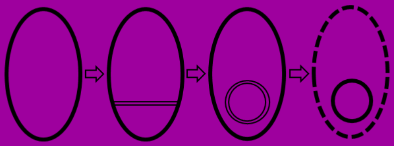
Pick up an extra ATP each time you land on a green space

Sporulation

This allows your bacteria to sporulate, therefore they can survive the stomach enzymes of animals that have ingested your bacterium



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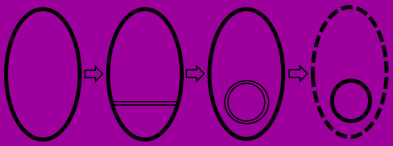

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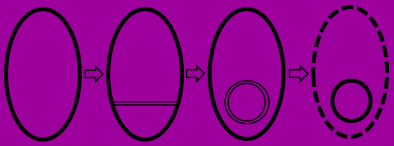

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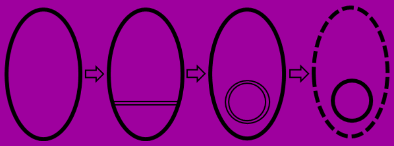

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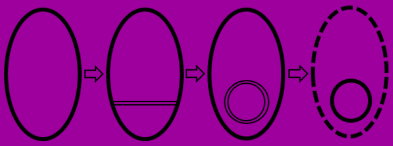

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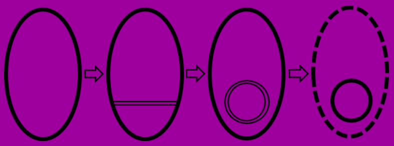

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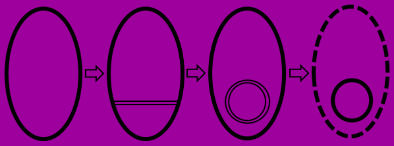

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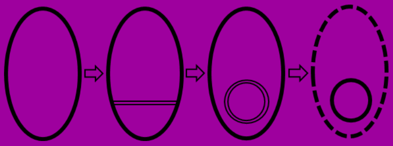

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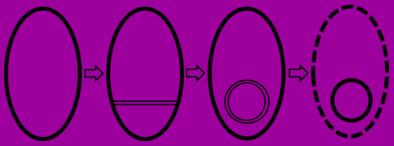
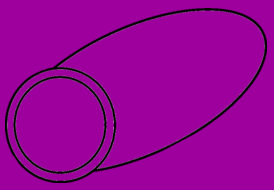


Glycocalyx capsule

This capsule gives your bacterium protection against desiccation



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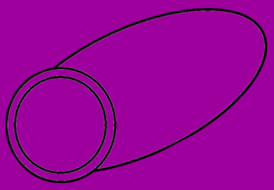

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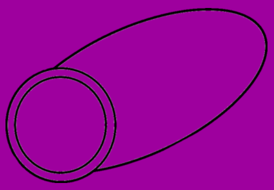

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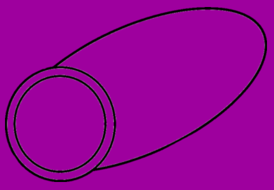

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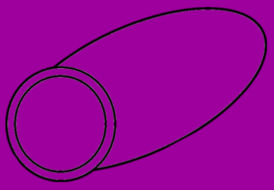

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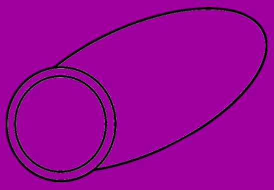

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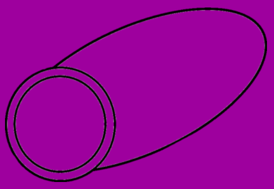

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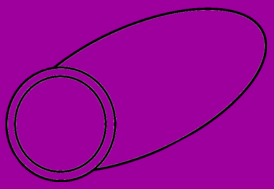

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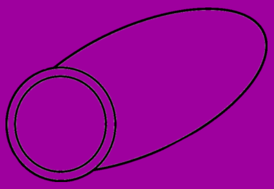
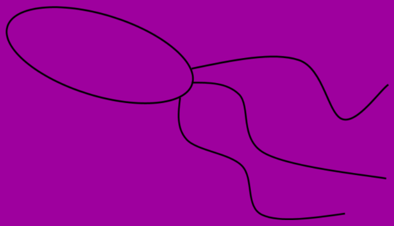


Flagella

A flagellum will allow your bacterium to avoid phagocytosis



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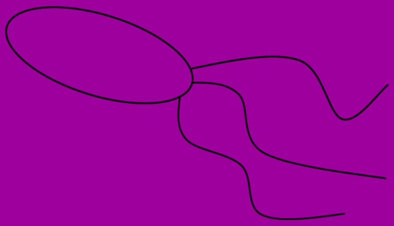

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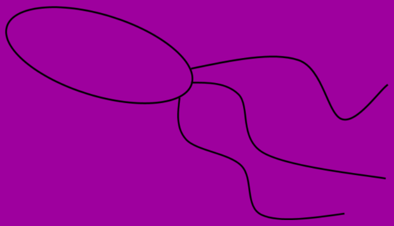

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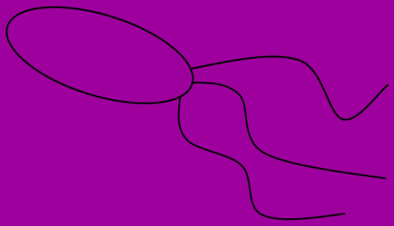

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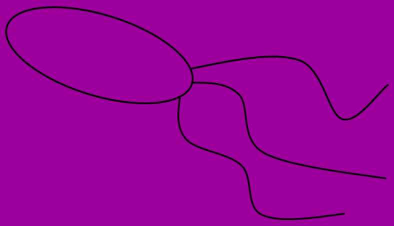

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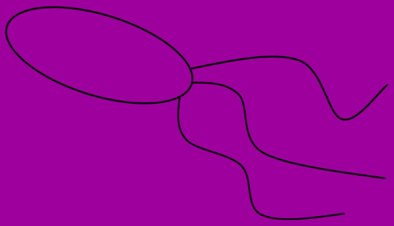

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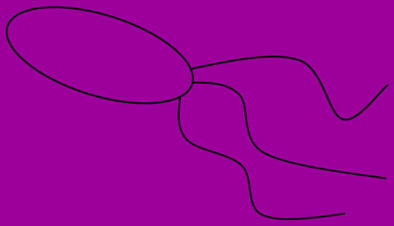

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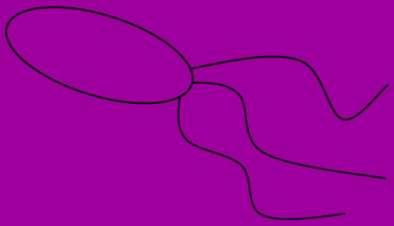

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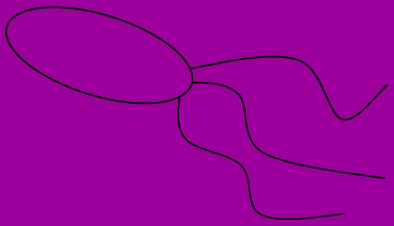
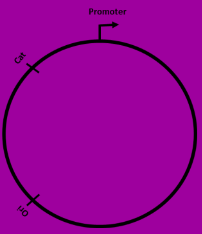


Cat-gene

This allows your
bacterium to survive in
environments containing
chloramphenicol



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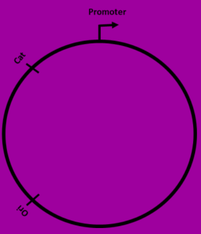

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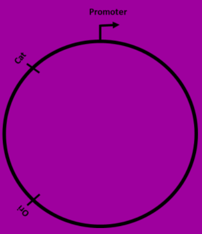

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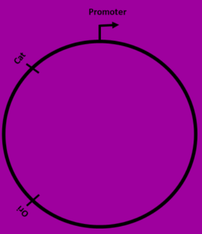

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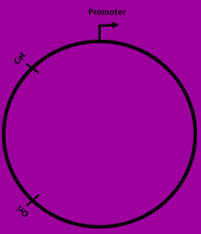

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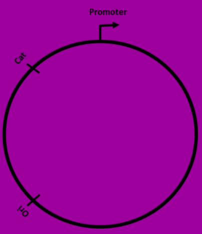

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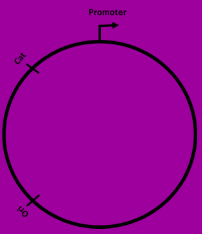

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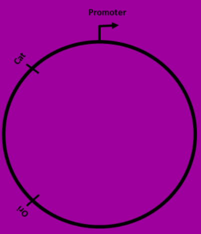

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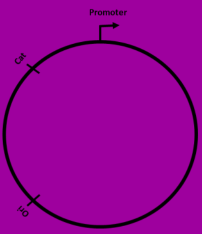
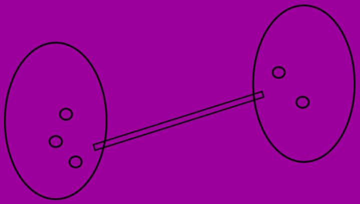


Pili

This allows your bacterium to conjugate (steal) another player's unintegrated plasmid either when sharing the same space OR on the



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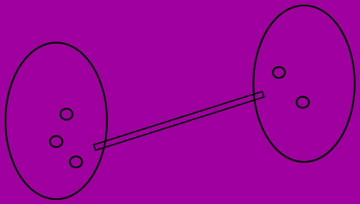

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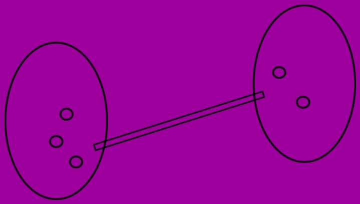

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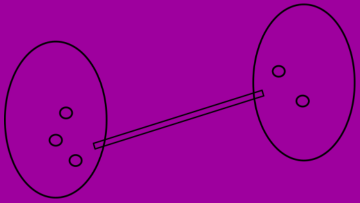

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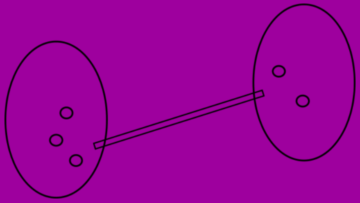
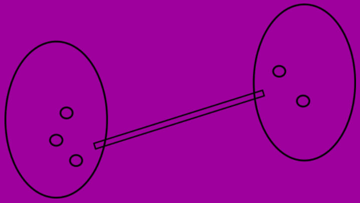


Pili

This allows your bacterium to conjugate (steal) another player's unintegrated plasmid either when sharing the same space OR on the



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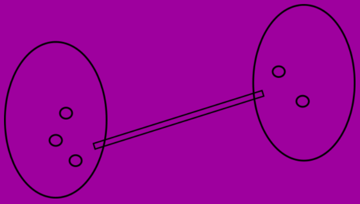

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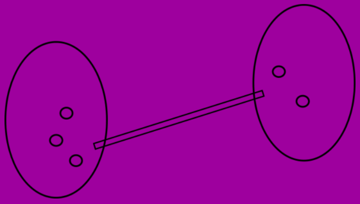

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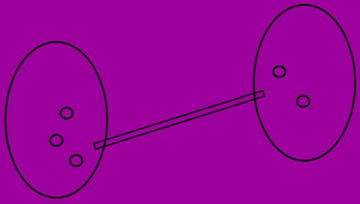
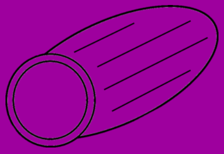


Slime Layer

The slime layer acts as a food reserve for your bacterium

Pick up an extra ATP each time you land on a green space



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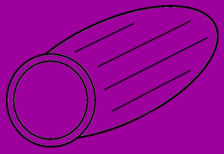

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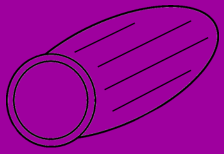

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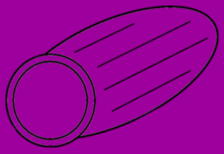

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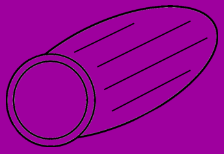

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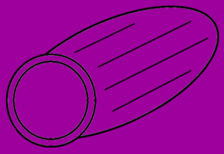

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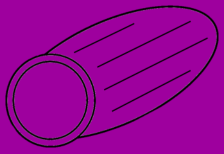

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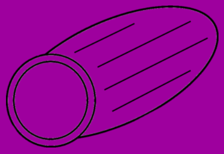

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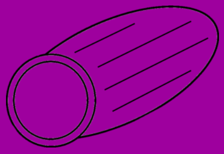
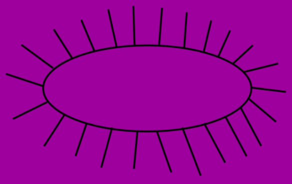


Fimbriae

This allows your
bacterium to attach
to biofilms, giving
them protections from
the immune system



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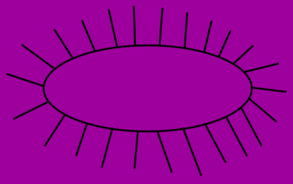

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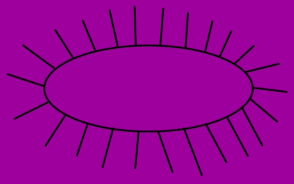

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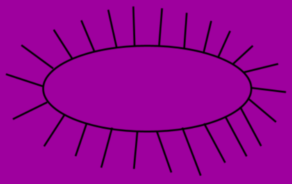

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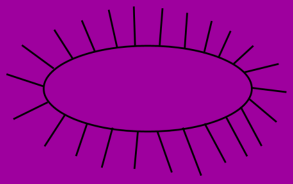

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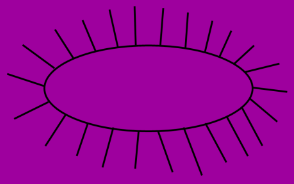

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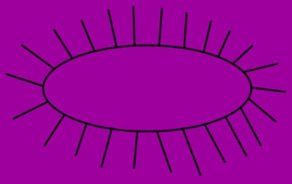

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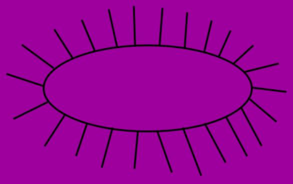

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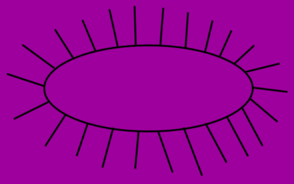
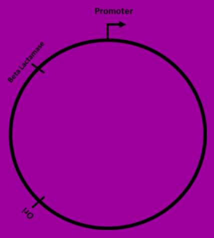


Beta-lactamase

This enzyme allows your bacterium to survive in environments containing beta-lactam antibiotics



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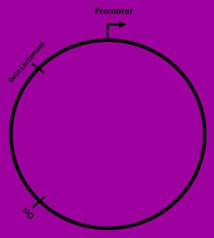

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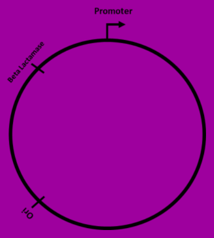

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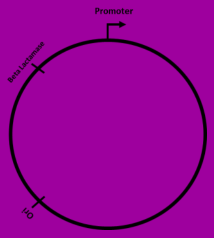

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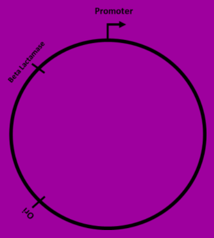

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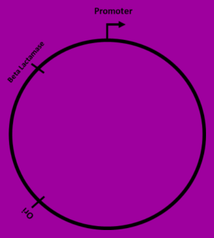

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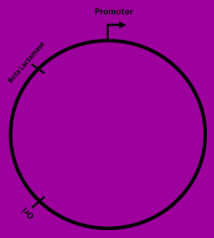

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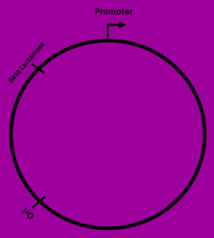

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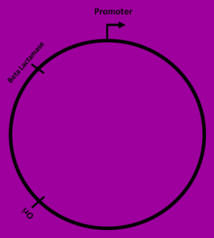
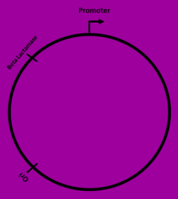


Lac-operon

This operon allows your bacterium to perform diauxic growth, making energy production more efficient

Pick up an extra ATP each time you land on a green space



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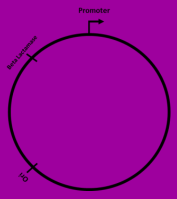

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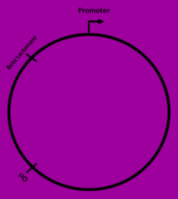

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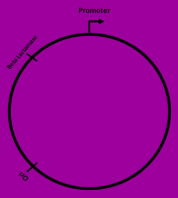

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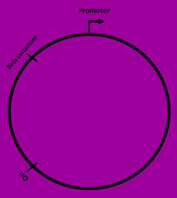

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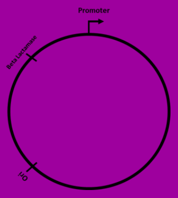

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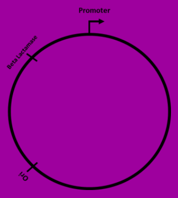

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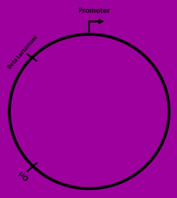

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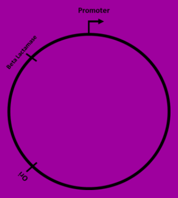

LuxO

This sensory protein allows your bacterium to perform quorum sensing

Jump 2 spaces ahead of the player in front of you, or if you're currently first place jump forward 2 spaces

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ArcAB

This two component sensory system allows your bacterium to sense changes in oxygen levels, making energy production more efficient

Pick up an extra ATP each time you land on a green space

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EnvZ- OmpR

This two component sensory system allows your bacterium to sense changes in osmotic pressure therefore prevent osmotic lysis

EnvZ- OmpR

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FNR

This one component sensory system allows your to bacterium produce energy in fully anaerobic conditions

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CheY-FliM

This two component sensory system allows your bacterium to sense chemicals and move towards more nutrient-rich spaces (requires a flagella)

Pick up an extra ATP each time you land on a green space

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Pick up an extra ATP each time you land on a green space

Trade in this card with **2 ATP** when you want to integrate a plasmid into your bacterium's chromosome

This makes the plasmid stable, preventing it from being stolen via conjugation or lost via plasmid loss

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