Please assemble your MicroBattle Guidebook as follows:

(1) Fold the pages in half to form your A5 Guidebook with images facing inwards.
(2) Arrange the pages in numbered order (smaller page numbers increasing in sequence on the left and larger page numbers decreasing on the right.
(3) Make sure the cover page and the back (this page) are flipped and appropriately placed on the back of your stack.
(4) Staple the sheets together (preferably through the middle crease).

MicroBattle Project was funded by the National Biofilms Innovation Centre (NBIC) Public Engagement Grant (2020-2021). Game Development:

Game Development: Ryan Griffiths, Yemane Tedros, Rebecca Thompson
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Find links to download files to print your own cards on:
Twitter: @project_ub

National Biofilms Innovation Centre

μB

Quadram Institute

MicroBattle

Guidebook

1st Edition

MicroBattle Project was funded by the National Biofilms Innovation Centre (NBIC) Public Engagement Grant 2020-2021.

Table of Contents

Please Glue the other side of this page to the back of the Guidebook for extra stability.

Please use this space to draft your favourite deck recipes or combinations:

Title:

Growth Promoting Battle Cards	Growth Penalty Battle Cards
Environment Battle Cards	Gene Modification Battle Cards
General Battle Cards	Microbe Cards

Title:

Growth Promoting Battle Cards	Growth Penalty Battle Cards
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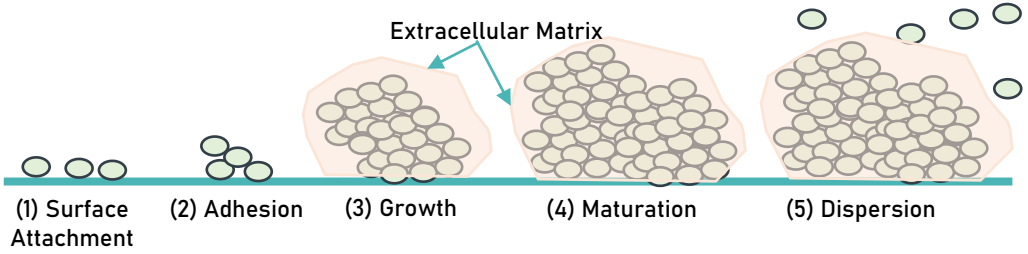
MicroBattle Introduction

MicroBattle (µB) is a competitive card game with the aim to win battles of simulated microbial biofilm growth against your opponent. You can choose from many microbes (in the form of Microbe Cards) and many growth conditions (in the form of Battle Cards) and customize your path to victory.



Biofilms mark a dramatic change in the life cycle of many microorganisms and is categorized into distinct steps. (1) First, attachment to a surface. Biofilms require an initial substrate to localize (2) Second, is further adhesion to that surface and to other microbes. (3) Third, marks the growth stage where microbes in the biofilm will multiply and deposit an extracellular matrix. This matrix provides protection and further substrate for attachment. (4) Fourthly, the biofilm matures. This summarizes many metabolic changes for the inhabitants of this biofilm and marks the time when the biofilm is at its strongest. (5) Finally, microbes may disperse/leave the biofilm in search of new nutrients and to start the process again.

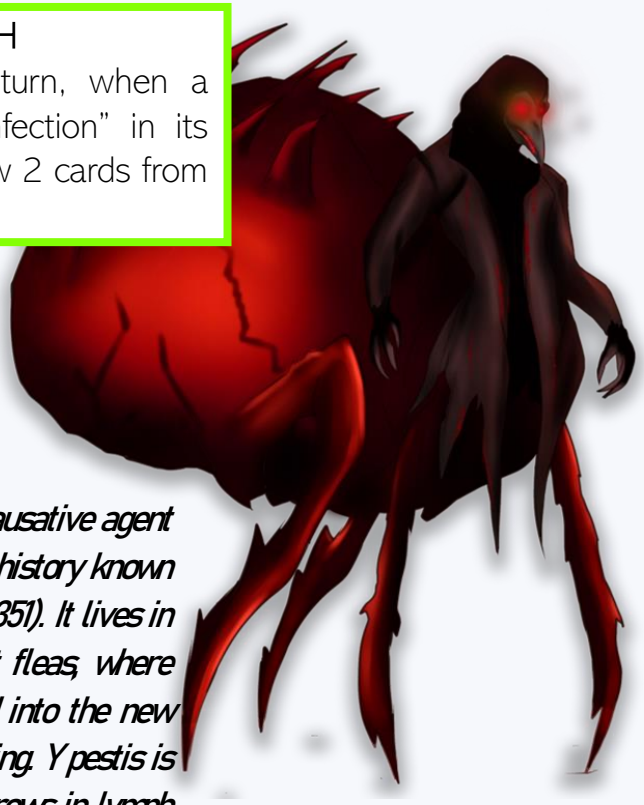
Whilst your microbes battle for biofilm supremacy please make sure to be courteous with your opponents!

Resistances: "Immune System".

Yassine – Sey

Yersinia pestis

Ability: BLACK DEATH
Once during your turn, when a battle card with "Infection" in its name is played, draw 2 cards from your deck.



Y. pestis is the predicted causative agent of the largest pandemic in history known as the Black Death (1347-1351). It lives in a reservoir of oriental rat fleas, where the biofilm is regurgitated into the new host when the flea is feeding. Y pestis is very resilient and freely grows in lymph nodes (immune active tissue).

Yersinia pestis Challenge

Win a battle in a single turn.

MicroBattle Rules

Aim of the Game: Take it in turns to reach 15 biofilm growth counters for your microbe before your opponent (2-4 players). A game has three "Battles" – with best of 3 Battles determining the winner.

Before the Game: Design a Battle Card Deck supporting the growth of a choice of 3 microbe cards that you have selected. There can only be a maximum of 3 of each kind of card and between 25 - 30 cards. See page 8 for help! Print or draw out your game board (page 7).

Before each Battle: From your roster of 3 microbe cards, select and place your first microbe into your microbe zone at same time as your opponent. Every Battle must start with a different microbe.

A Battle starts with 3 cards in the hand from a shuffled Battle Card Deck. Try not to show your opponent your cards.

A Turn starts by drawing a new card, then grow your microbe's biofilm or disrupt your opponent's microbe's growth using any number of battle cards.

At 10 biofilm growth counters your microbe cannot lose more than 2 counters as a result of a growth penalty battle card (↓) (the biofilm has matured and become more resistant).

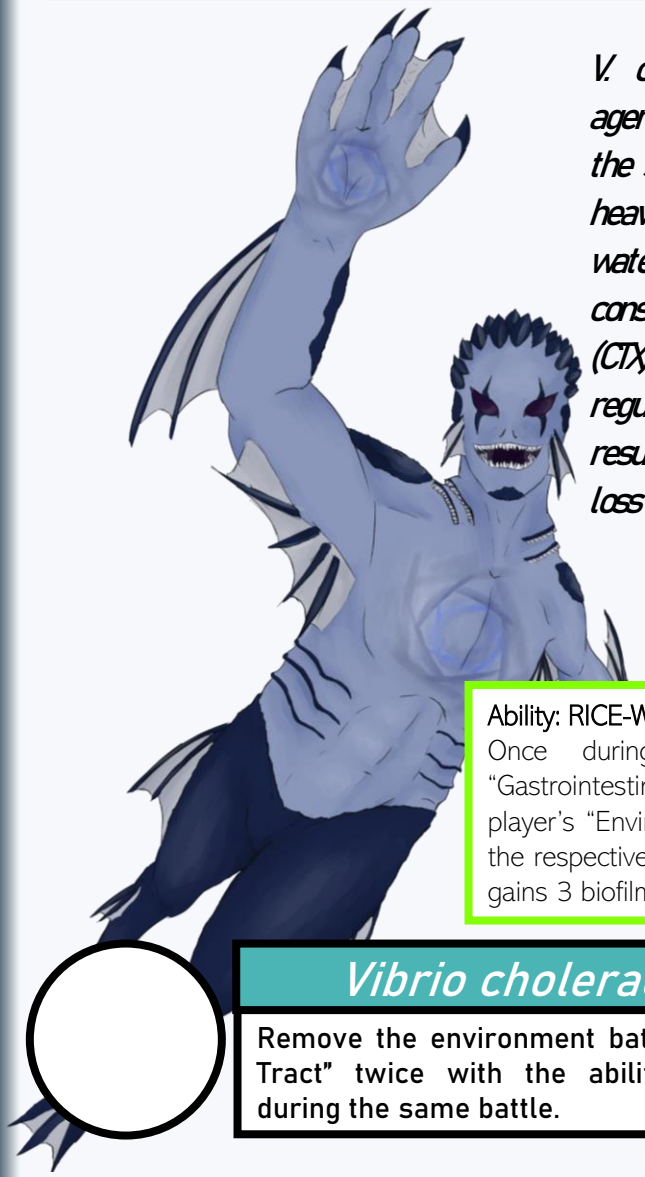
At 15 biofilm growth counters, your microbe wins the round and is ready to disperse. These can be monitored on your game board.

A player also loses the battle if they have no more playable cards after their battle card deck is empty.

Resistances:
None.

Upgrade47

Vibrio cholerae



V. cholerae is the causative agent of cholera; an infection of the small intestine resulting in heavy diarrhea dubbed "rice-water" due to appearance and consistency. The cholera toxin (CTX) interferes with the host's regulation of water and ions resulting in a cascade of fluid loss of up to 2 litres per hour.

Ability: RICE-WATER STOOL
Once during your turn, send one "Gastrointestinal Tract" card from any player's "Environment Battle Card Zone" to the respective waste zone and this microbe gains 3 biofilm growth counters.

Vibrio cholerae Challenge

Remove the environment battle card "Gastrointestinal Tract" twice with the ability "RICE-WATER STOOL" during the same battle.

Microbe Card Guide

Microbe Cards represent the microbes you have chosen to grow against your opponents. They have several important features illustrated below.

Environment Bonus Symbols: These relate to effects in Battle Cards and the environmental niche of the microbe.

- Aquatic
- Plant Host
- Gastrointestinal Tract
- Infection
- Extremophile
- Soil

Illustrator

Full name of the microbe.

This microbe is unaffected by all battle cards that contain the same listed words in the title, e.g., "Immune System – Phagocytosis".

An ability that is a biological feature of the microbe is written here. Use these to gain advantage in battle.

Resistances: "Radiation".

Upgrade47

Sulfolobus acidocaldarius

S. acidocaldarius was first isolated from the thermal hot springs of the Yellowstone National Parks in the USA. It thrives readily during acidic (low pH) conditions at around 65-90° C. It is also able use CO_2 as a carbon source and metabolises sulphur present in the hot spring. Unlike many other archaea, S. acidocaldarius is also able to utilise a wide range of carbon sources.

Ability: SOPHISTICATED DNA REPAIR
Every time a battle card with "Radiation" or "Extremophile" in its name is played, this microbe gains 1 biofilm growth counter.

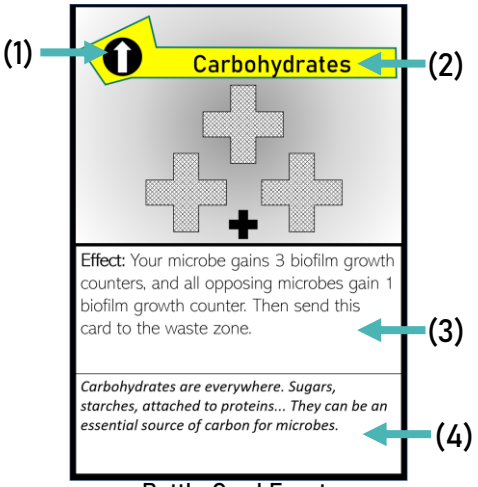
Sulfolobus acidocaldarius Challenge

Win a battle against another microbe with the "Extremophile" environment bonus.

Battle Card Guide

The front of the Battle Card has several features:

(1) A symbol identifying the battle card type.
(2) A name.
(3) An effect: The text here determines your action in the game.
(4) A flavour text describing some biological or chemical aspects of the card.



Battle Card Front

Battle Cards have been grouped into 5 types: Growth Promoting, Growth Penalty, Environment, Gene Modification and General. They each have an identifying symbol shown below:

Growth Promoting: These go into the battle card zone. These cards increase biofilm growth counters.

Growth Penalty: These go into the battle card zone. These cards decrease biofilm growth counters.

Environment: These go into the environment battle card zone. They can only be removed by the effect of another battle card, microbe or replaced with a new environment battle card.

Gene Modification: These go into gene modification battle card zone. They can only be removed by the effect of another battle card, or microbe.

General: These cards go into the battle card zone.

Resistances: "Antibiotics".

abhimanyartbot

Streptomyces coelicolor

Streptomyces are considered antibiotic factories. They are actively used in the pharmaceutical sector to produce and discover new antibiotics. They have a complex lifecycle that govern the formation of long hyphal structures that end in a sporulation stage. The smell of earth can also be partially attributed to the volatile geosmin contained in the spores.

Ability: ANTIBIOTIC FACTORY
Whenever this microbe reaches 7 or more biofilm growth counters, add 1 battle card with "Antibiotics" in its name to your hand from your Battle Card Deck. Then, shuffle the deck.

Streptomyces coelicolor Challenge

Win a battle in which you have used the growth penalty battle card "Antibiotics" at least twice.

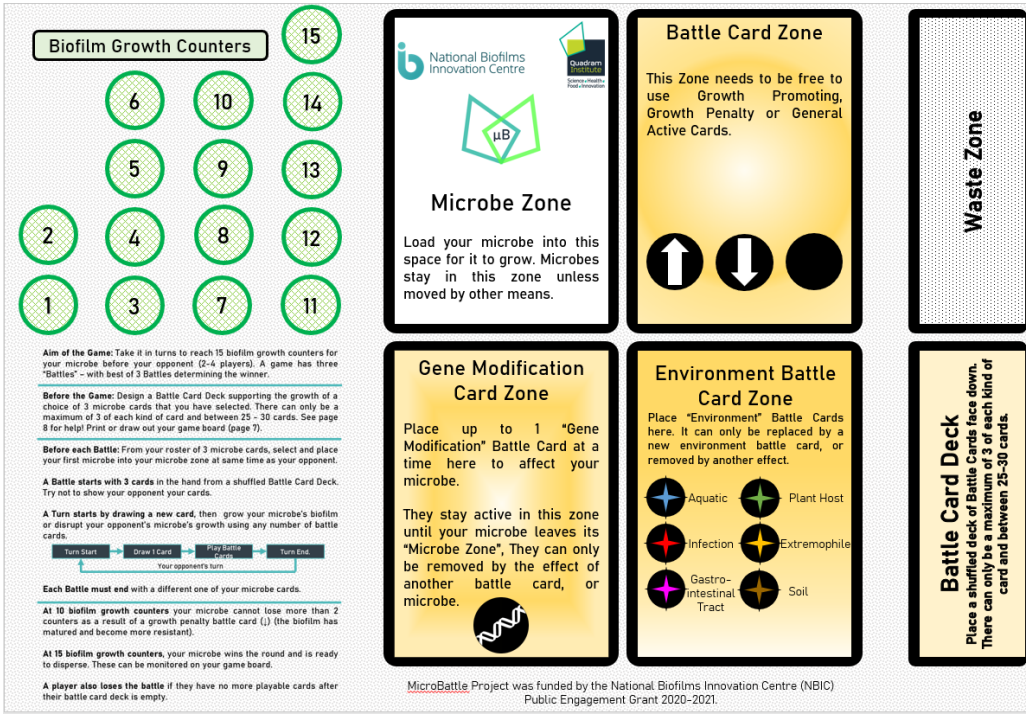
Game Board Guide

The Game Board can be printed (links on twitter @project_ub) or you can draw your own on a A4 piece of paper according to the image below.

It is divided into different zones for different microbe and battle cards.

A panel of biofilm growth counters is provided for the players to keep track of their growths and losses using a token/coin/die.

The rules can also be found on the board on the bottom left.



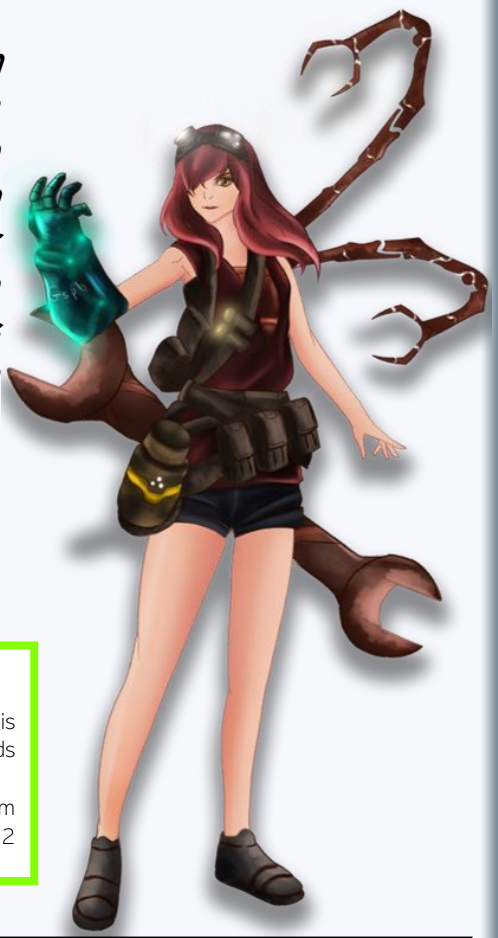
MicroBattle Project was funded by the National Biofilms Innovation Centre (NBIC) Public Engagement Grant 2020-2021.

Resistances:
None.

Yassine – Sey

Streptococcus gordonii

S gordonii is a pioneer biofilm builder of dental surfaces. As a consequence, it provides a surface substrate for many other microbes to adhere and colonise as well. Under rare circumstances, S gordonii can cause infective endocarditis (infection of heart and artery) when dislodged into the blood stream



Ability: PIONEER BIOFILM BUILDER
The following abilities apply:

- During your turn, you can swap this microbe with any other of your microbe cards retaining any biofilm growth counters gained.
- Once per turn, you can send 1 card from your hand to the waste-zone and this microbe gains 2 biofilm growth counters.

Streptococcus gordonii Challenge

Win 2 battles in the same game after using the ability "PIONEER BIOFILM BUILDER" to swap into other microbes.

Battle Card Deck Creation Guide

Generally, your battle cards should compliment the growth and strengths of the three microbes you choose. There can only be a maximum of 3 of each kind of card and between 25-30 cards.

To start, we recommend a deck size of 27 cards, of which ~50% are Growth Promoting Battle Cards and the rest are spread between the other battle card types.

You can create your own deck using the "Custom MicroBattle Deck Template" and dragging appropriate card images into the desired positions. Below is an example deck recipe and other premade deck recipes are available.

Title: HUMAN GUT SYMBIONTS	
Growth Promoting Battle Cards	**Growth Penalty Battle Cards**
➢ 3 x Muc2 – Mucin ➢ 3 x Prebiotics ➢ 3 x Dietary Polyphenols ➢ 3 x Human Milk Oligosaccharides ➢ 1 x Adhesion Protein	➢ 3 x Immune System – Innate Immunity ➢ 3 x Immune System - Phagocytosis
Environment Battle Cards	**Gene Modification Battle Cards**
➢ 3 x Gastrointestinal Tract	➢ 1x Gene Modification - Resistance
General Battle Cards	**Microbe Cards**
➢ 1 x Niche Occupation ➢ 1 x Chemotaxis ➢ 1 x Community Biofilm ➢ 1 x Electrochemical Communication	*Bifidobacterium breve* *Lactobacillus casei* *Limosilactobacillus reuteri*

Resistances:
None.

Olegtsoy

Staphylococcus aureus

S. aureus is a commensal bacterium colonising many host environments, but it is also an opportunist pathogen that can cause devastating infections. The biofilms are highly resistant to stressors by developing antibiotic resistance and production of staphyloxanthin, a golden pigment, providing protection from the immune system

Ability: ACQUIRED RESISTANCE
When this microbe loses biofilm growth counters from a "Growth Penalty Battle Card" (↓), it gains resistance to cards with that exact same name for the rest of the battle.

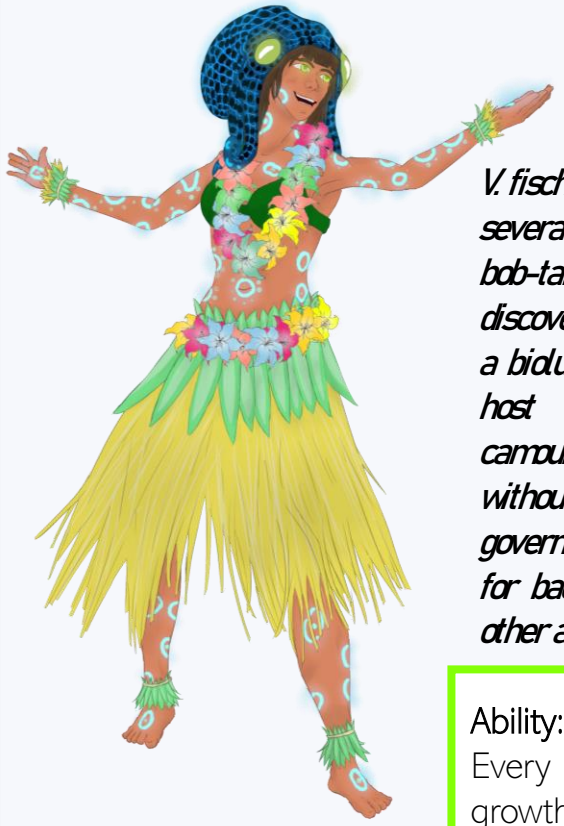
Staphylococcus aureus Challenge

Gain resistance to 3 different growth penalty battle cards during the same battle.

Upgrade47

Resistances:
None.

Aliivibrio fischeri



V. fischeri has a unique relationship with several marine animals including the bob-tail squid where it was first discovered. Biofilms of this microbe form a bioluminescent light organ inside the host which allows the squid to camouflage so it can hunt its prey without casting shadow. This process is governed by quorum sensing, a means for bacteria to chemically sense each other and synchronize their activities.

Ability: BIOLUMINISCENT SQUID
Every time this microbe's biofilm growth counters go to 7 or higher, draw 1 card.

Aliivibrio fischeri Challenge

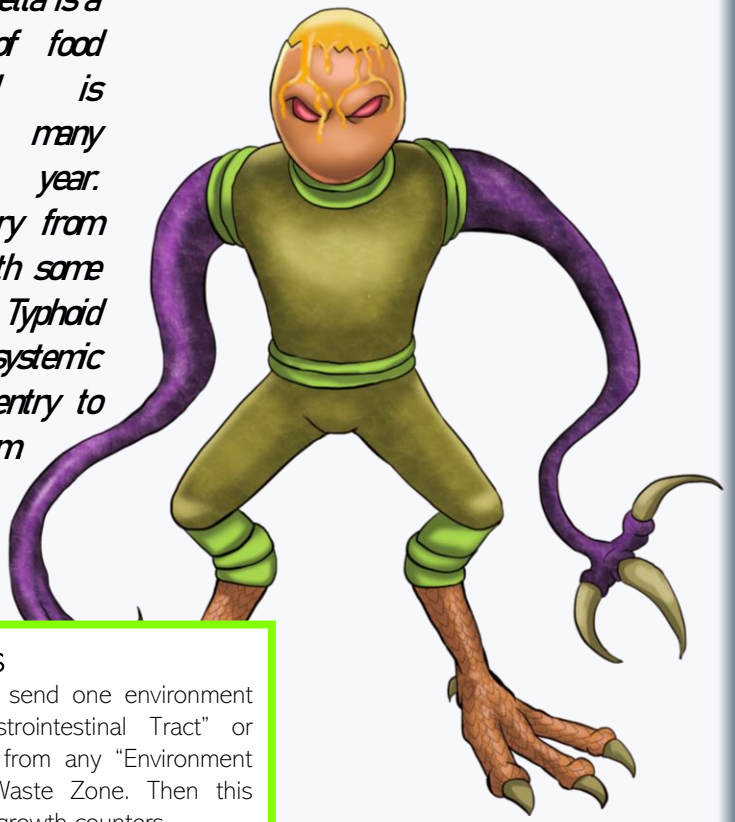
In the same battle draw 2 cards using the *A. fischeri's* ability "BIOLUMINISCENT SQUID" and win the battle with at least 2 cards in the hand.

Resistances:
None.

Elangkarosingo

Salmonella enterica

Infection by Salmonella is a common cause of food poisoning and is responsible for many deaths every year. Symptoms can vary from mild to severe, with some strains resulting in Typhoid fever from a systemic infection through entry to the lymphatic system



Ability: SALMONELLOSIS
Once during your turn, send one environment battle card with "Gastrointestinal Tract" or "Infection" in its name from any "Environment Battle Zone" to the Waste Zone. Then this microbe gains 2 biofilm growth counters.

Salmonella enterica Challenge

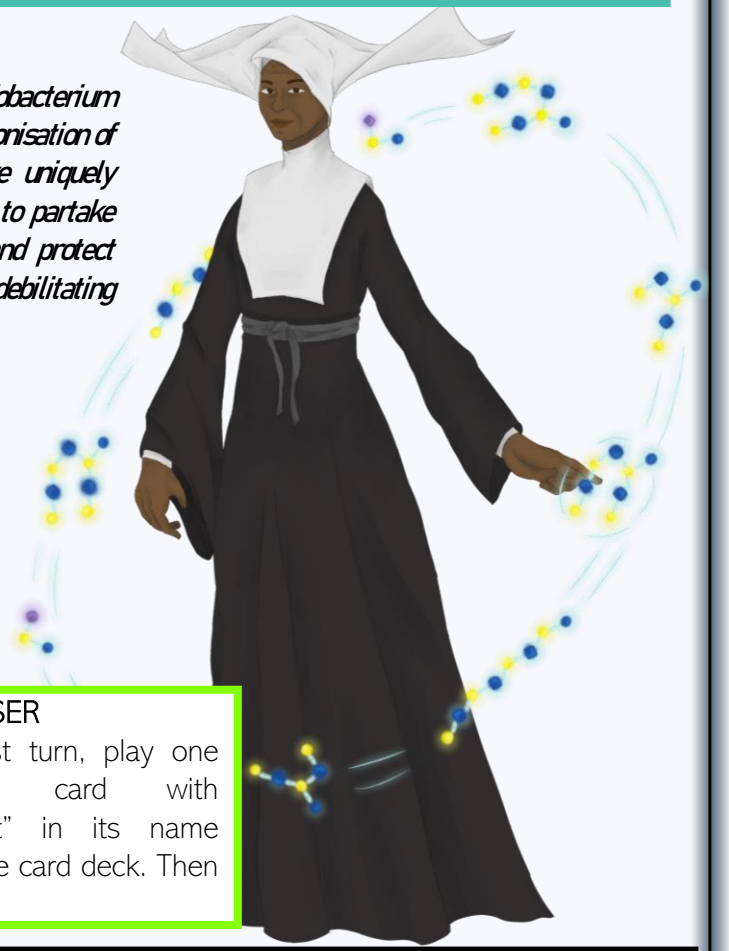
Win a battle with "Gene Modification – Resistance" in your Gene Modification zone.

Upgrade47

Resistances: "Immune System".

Bifidobacterium breve

Several species of Bifidobacterium are well known for the colonisation of the infant gut. They have uniquely coevolved with mammals to partake in the breast-milk diet and protect the infant from debilitating gastrointestinal diseases.



Ability: EARLY COLONISER

On this microbe's first turn, play one environment battle card with "Gastrointestinal Tract" in its name directly from your battle card deck. Then shuffle the deck.

Bifidobacterium breve Challenge

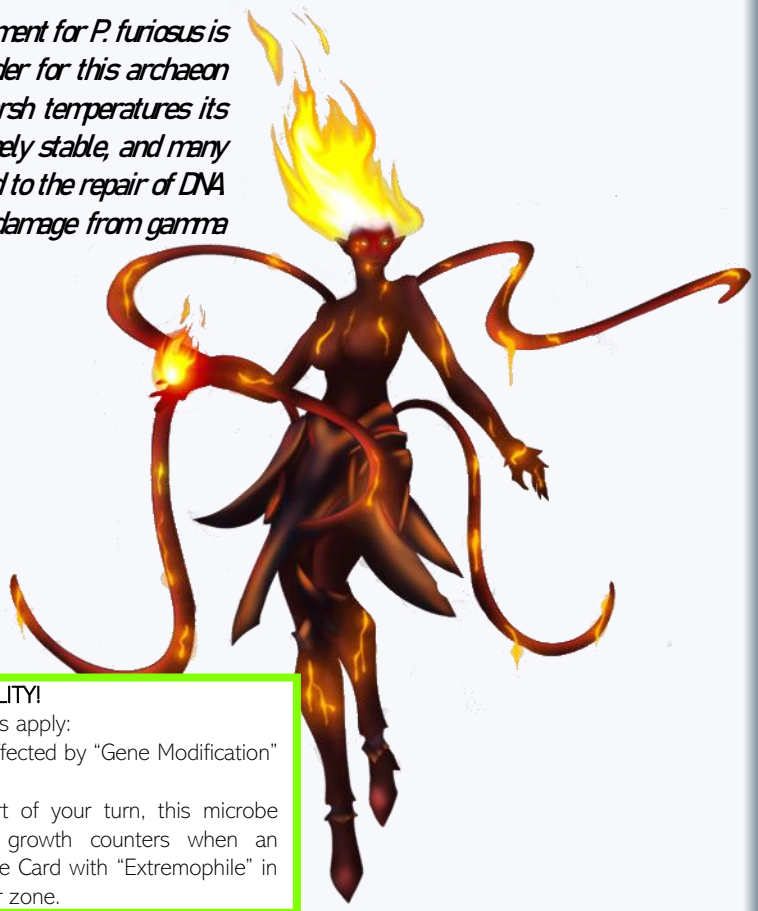
Win a battle (reaching 15 biofilm growth counters) after using the battle card "Human Milk Oligosaccharides" and reducing the opponent's biofilm growth counters to 5 or less.

Resistances: "Radiation".

Yassine – Sey

Pyrococcus furiosus

The optimal environment for P. furiosus is around 100°C. In order for this archaeon to survive these harsh temperatures its proteins are extremely stable, and many have been dedicated to the repair of DNA. It can even repair damage from gamma radiation...



Ability: THERMAL STABILITY!

Two following two effects apply:

- This card is not affected by "Gene Modification" Battle Cards.
- During every start of your turn, this microbe gains 2 biofilm growth counters when an Environment Battle Card with "Extremophile" in its name is in your zone.

Pyrococcus furiosus Challenge

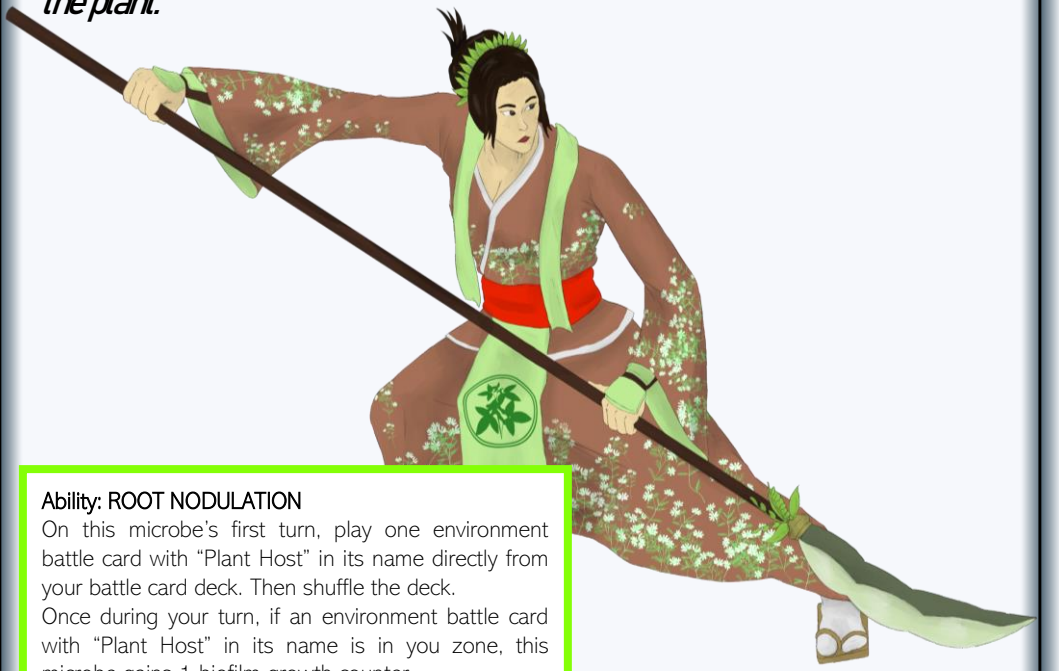
Win a battle in 3 turns.

Upgrade47

Resistances:
None.

Bradyrhizobium japonicum

B. japonicum is part the group of nitrogen fixing bacteria and forms a symbiotic relationship with soybeans. The plant provides nourishment and a protected root nodule structure. In return B. japonicum harvests atmospheric nitrogen and converts it into ammonia which is essential for the plant.



Ability: ROOT NODULATION
On this microbe's first turn, play one environment battle card with "Plant Host" in its name directly from your battle card deck. Then shuffle the deck.
Once during your turn, if an environment battle card with "Plant Host" in its name is in you zone, this microbe gains 1 biofilm growth counter.

Bradyrhizobium japonicum Challenge

Win a battle while an environment battle card with "Plant Host" in its name is in your zone.

Resistances:
None.

Upgrade47

Pseudomonas syringae

P. syringae is one of the most common plant pathogens. It uses biofilm as key step in its plant colonisation strategy. It is also responsible for frost damage in plants by producing Ice Nucleation-Active proteins. These lower the freezing temperature of water causing frost damage inside the plant and releasing nutrients to the bacteria outside.

Ability: ICE NUCLEATION-ACTIVE
Once during your turn, send one battle card with "Plant Host" in its name from card from any player's "Environment Battle Card Zone" to the respective waste zone and this microbe gains 3 biofilm growth counters.

Pseudomonas syringae Challenge

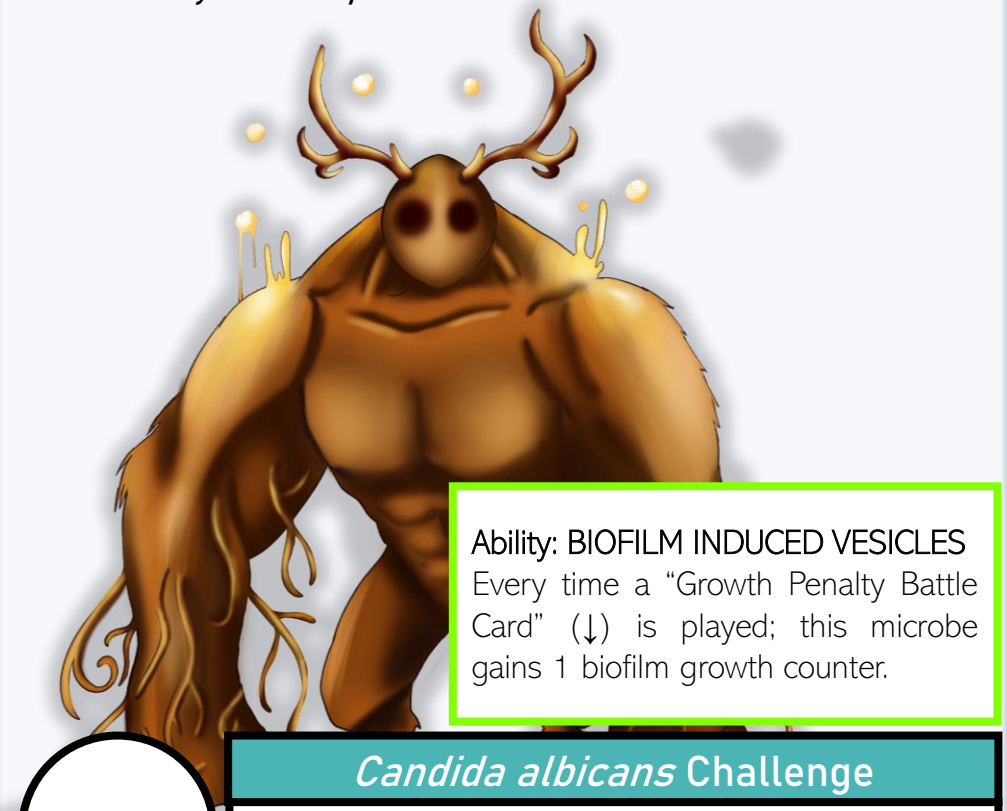
Win a battle (reaching 15 biofilm growth counters) after using the ability "ICE NUCLEATION- ACTIVE".

Yassine_Sey

Resistances:
"Antibiotics".
"Bacteriophage"

Candida albicans

C. albicans is a commensal fungus that is common in the mouth and digestive tract. It also can present as an opportunistic pathogen during times of a weakened immune system, or the local population of microbes has been significantly disturbed. All forms of life produce vesicles (a membrane bubble filled with a diverse possible cargo) and C. albicans may use these to protect itself from attack in its biofilm state.



Ability: BIOFILM INDUCED VESICLES
Every time a "Growth Penalty Battle Card" (↓) is played; this microbe gains 1 biofilm growth counter.

Candida albicans Challenge

Win a battle (reaching 15 biofilm growth counters) after a growth penalty battle card is played (triggering the ability "BIOFILM INDUCED VESICLES").

Resistances:
None.

Upgrade47

Pseudomonas aeruginosa

P. aeruginosa is an opportunistic pathogen that is known to be able to colonise many different natural and artificial surfaces. The biofilms it develops are extremely resistant. Particularly babies, elderly, people with particular genetic disorders such as cystic fibrosis and those with a weakened immune system are vulnerable to infection.

Ability: OPPERTUNIST
During your turn, your microbe has access to all opponent's active environment battle card effects.

Pseudomonas aeruginosa Challenge

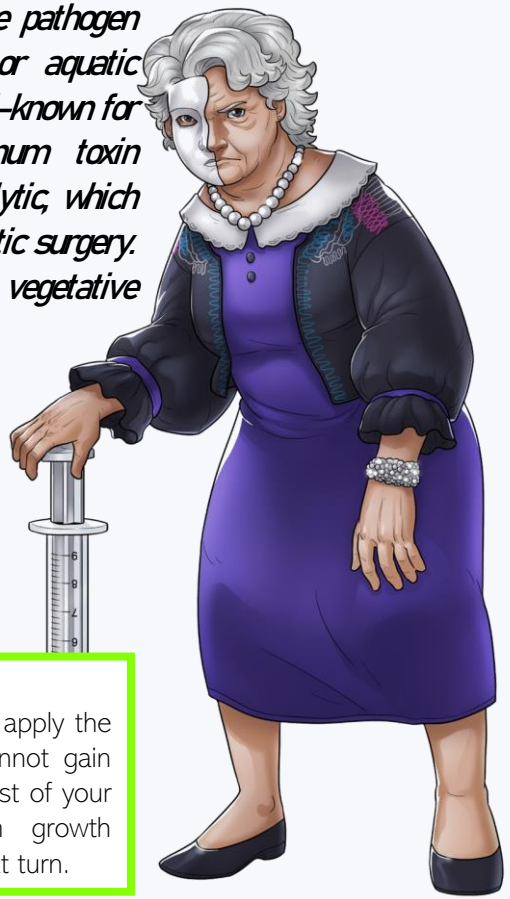
During a battle with 3-4 players, use the effects of 3 different environment battle cards during your turn.

Ryan Prastian

Resistances:
None.

Clostridium botulinum

C. botulinum is a food borne pathogen and also present in soil or aquatic environments. It is most well-known for the production of botulinum toxin causing potent muscle paralytic, which has been repurposed in plastic surgery. It also can enter a resistant vegetative state known as endospore.



Ability: ENDOSPORE
At the start of your turn, you can apply the following effect: This microbe cannot gain biofilm growth counters for the rest of your turn and cannot lose biofilm growth counters until the start of your next turn.

Clostridium botulinum Challenge

Use 3 growth penalty battle cards during your turn and win the same battle.

Resistances:
None.

Upgrade47

Prochlorococcus marinum

Photosynthesis describes the process of converting light to chemical energy with often oxygen being a by-product.

P. marinum are the smallest photosynthetic organisms on the planet, but by occupying warm oceans end up supplying Earth with the greatest contribution of oxygen.

Ability: PHOTOSYNTHESIS
Once during your turn, during local daytime, this microbe gains 2 biofilm growth counters.

Prochlorococcus marinum Challenge

Win a battle during local night-time.

Yassine – Sey

Resistances:
"Antibiotics".
"Bacteriophage"

Cryptosporidium parvum

Cryptosporidiosis is caused by ingestion of water contaminated with mammalian parasite C. parvum, and is typically self-limiting in people, but can be dangerous for those who have weakened immune systems. It uses large glycoproteins similar to those in human mucus to prevent destruction and attach to the host small intestine or respiratory tract.

Ability: RESISTANT OOCYTE
This microbe's biofilm growth counters cannot be reduced while biofilm growth counters are 5 or less.

Cryptosporidium parvum Challenge

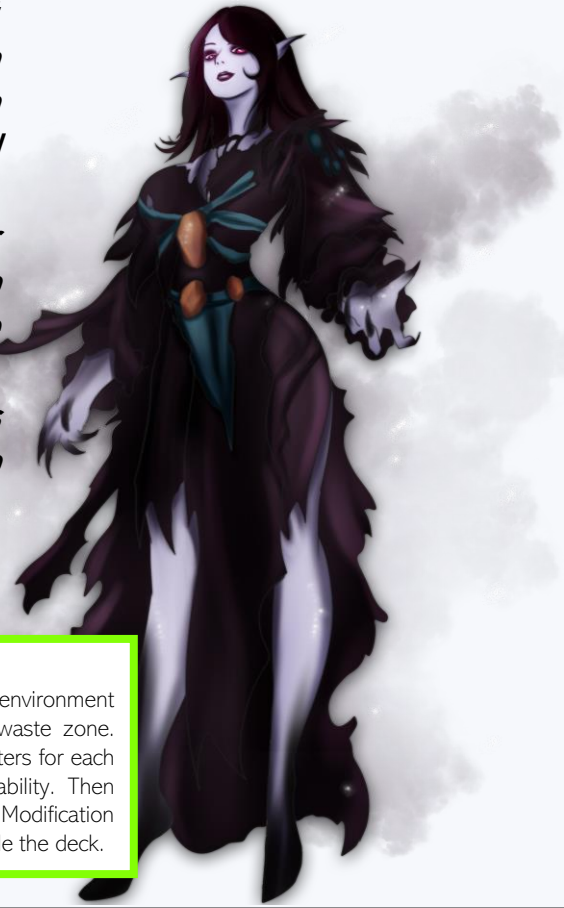
Win a battle while an environment battle card with "Gastrointestinal Tract" in its name is in your zone.

Resistances:
"Antibiotics".
"Bacteriophage"

Yassine – Sey

Phytophthora infestans

P. infestans is one of the most destructive plant pathogens on Earth. It is classified as an oomycete (or water mold) and mainly infects potato plants. Hence, it is most recognised for causing over 1 million people to die of starvation during the Great Irish Famine in the 1840s. To this day it still costs billions of pounds in damages to potatoes world-wide.



Ability: BLIGHT
Once per battle, send all "Plant Host" environment cards in all environment zones to the waste zone. This microbe gains 2 biofilm growth counters for each card sent to the waste zone by this ability. Then search your battle card deck for a Gene Modification Battle Card and add it to your hand. Shuffle the deck.

Phytophthora infestans Challenge

Exchange your "Gene-Modification" battle card three times during a battle through the ability "BLIGHT".

Yassine_Sey

Resistances:
None.

Geobacter sulfereducens

Geobacter species are well known for their ability to use metals as part of their respiration (means to get chemical energy). G. sulfureducens forms nanowires to conduct and produce electricity. They are actively explored as living batteries and generators, as well as bioremediation (recovery) of environments that have been contaminated by radioactive metals such as uranium

Ability: NANOWIRES
Once during your turn, you can shuffle one card in your hand into your deck and draw 1 new card.

Geobacter sulfereducens Challenge

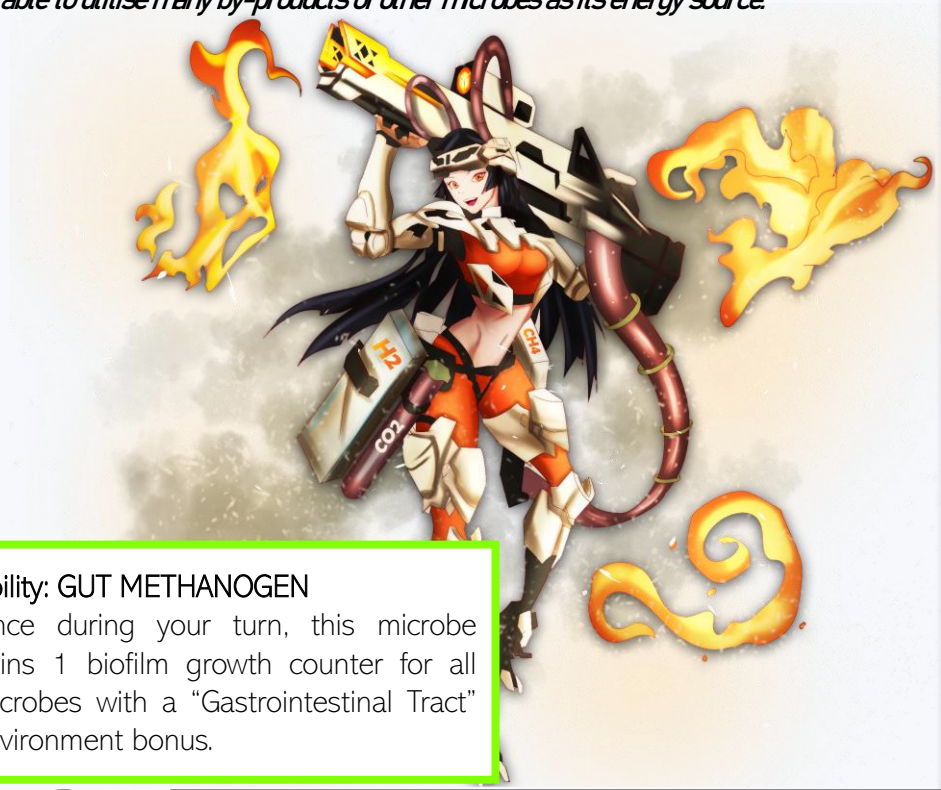
Win a battle using the effect of the battle card "Bioremediation".

Resistances:
None.

Yassine_Sey

Methanobrevibacter smithii

M smithii is the main archaea in the human gastrointestinal tract. Very few microbes can produce methane by harvesting carbon and hydrogen from their environment, and so far, all methanogens have been classified as archaea. In the gut, M smithii is able to utilise many by-products of other microbes as its energy source.



Ability: GUT METHANOGEN
Once during your turn, this microbe gains 1 biofilm growth counter for all microbes with a "Gastrointestinal Tract" environment bonus.

Methanobrevibacter smithii Challenge

Win a multi-battle with 3 or 4 players.

Upgrade47

Resistances:
"Radiation".

Halobacterium salinarum

As a halophile, H salinarum can thrive in high salt concentrations. The bright pink/red colour in some salt lakes and in the Dead Sea is partially due to archaea such as H salinarum that produce a pigment to protect from UV radiation. It is unable to metabolise many extracellular carbohydrates but produces all sugars itself through the gluconeogenesis process.

This also makes Halobacteria candidates for survival on extra-terrestrial planets, like Mars.

Ability: ANCIENT DNA

Two following two effects apply:

- This microbe only gains a maximum of 1 biofilm growth counters from "Growth Promoting" (↑) Battle Cards.
- Once during your turn, this microbe gains 2 biofilm growth counters.

Halobacterium salinarum Challenge

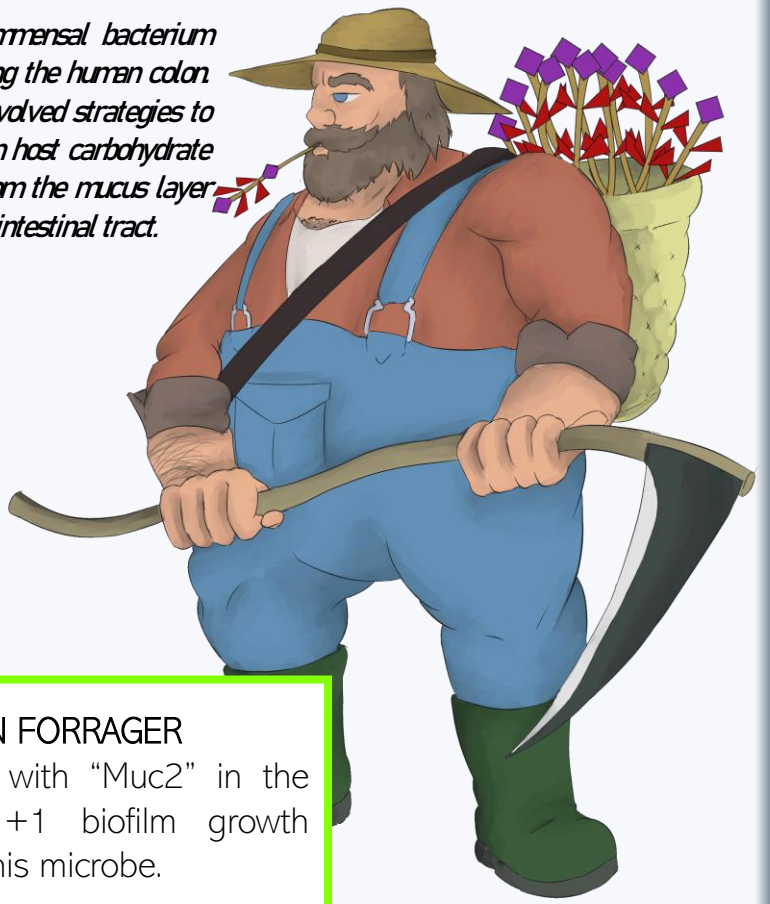
Win a battle without using any growth promoting battle cards.

Resistances:
None.

Upgrade47

Mediterraneibacter gnavus

M gnavus is a commensal bacterium often found occupying the human colon. As a result, it has evolved strategies to harvest sugars from host carbohydrate sources, such as from the mucus layer that is covering the intestinal tract.



Ability: MUCIN FORRAGER

Battle Cards with "Muc2" in the name give +1 biofilm growth counters to this microbe.

Mediterraneibacter gnavus Challenge

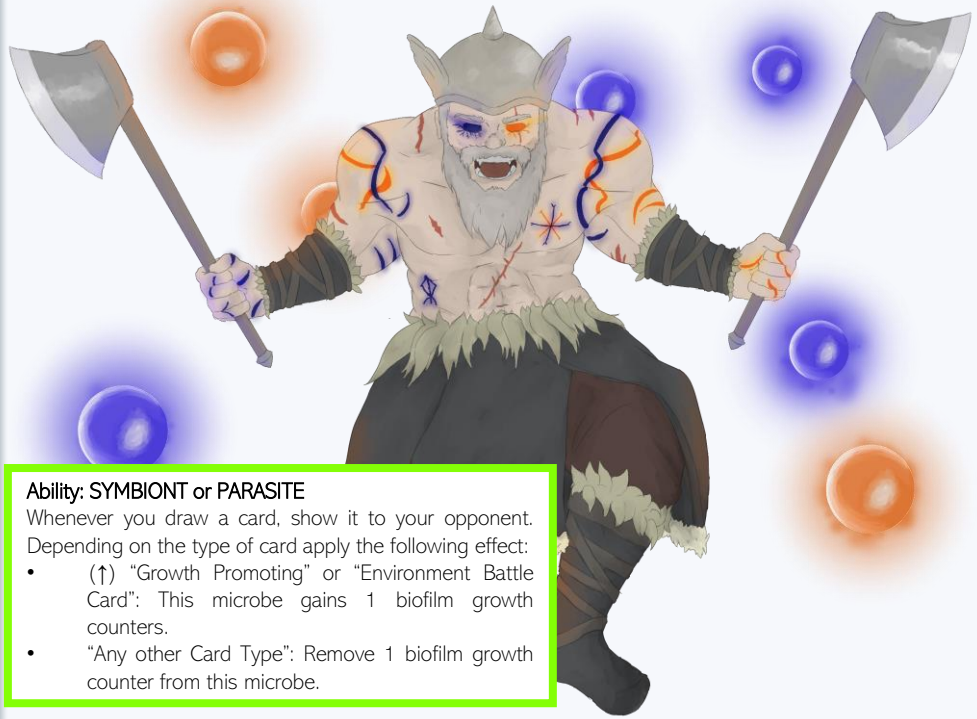
Use the growth promoting battle card "Muc2 – Mucin" three times during the same battle.

Upgrade47

Resistances:
"Radiation".

Ignicoccus hospitalis

L. hospitalis is a hyperthermophilic archaea found at hydrothermal vents (80°C) and uses sulfur as its main energy source. It also serves host to super small Nanoarchaeum equitans, but their relationship is not fully understood.



Ability: SYMBIONT or PARASITE

Whenever you draw a card, show it to your opponent. Depending on the type of card apply the following effect:

- (↑) "Growth Promoting" or "Environment Battle Card": This microbe gains 1 biofilm growth counters.
- "Any other Card Type": Remove 1 biofilm growth counter from this microbe.

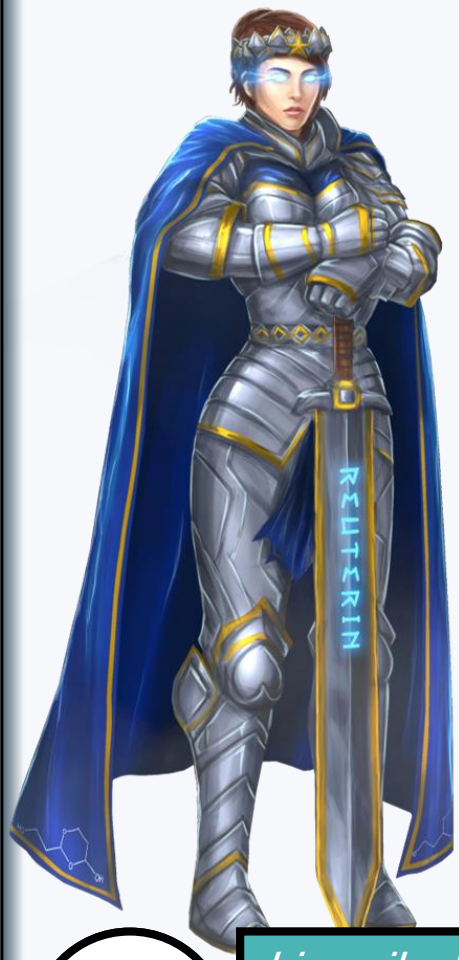
Ignicoccus hospitalis Challenge

During a battle, gain 8 biofilm growth counters through the ability "SYMBIONT or PARASITE".

Resistances:
"Immune System".

Endless_Studio

Limosilactobacillus reuteri



L. reuteri is a beneficial bacteria and true symbiont of vertebrates, typically colonising (occupying) the small intestine. It has been shown to be able to combat a wide variety of harmful gut bacteria with the production of the broad-spectrum anti-microbial Reuterin.

Ability: REUTERIN

Once during your turn, you can remove 1 biofilm growth counter from all opposing microbes.

Limosilactobacillus reuteri Challenge

Win a multi-battle with 3 or 4 players using *Limosilactobacillus reuteri*.

Elangkarosingo

Resistances: "Immune System".

Lactobacillus casei

L. casei has been observed in the fermentation of dairy products, and vegetation (e.g., green olives). It is also often shown as a probiotic bacterium in many mammals with several health benefits attributed to its colonisation of the gastrointestinal tract (gut) including regulation and communication with the host immune system and nervous system

Ability: IMMUNOREGULATOR

Every time this microbe reaches 7 or more Biofilm Growth Counters; search your "Battle Card Deck" for 1 card with "Immune System" in its name and add it to your hand. Then shuffle your deck.

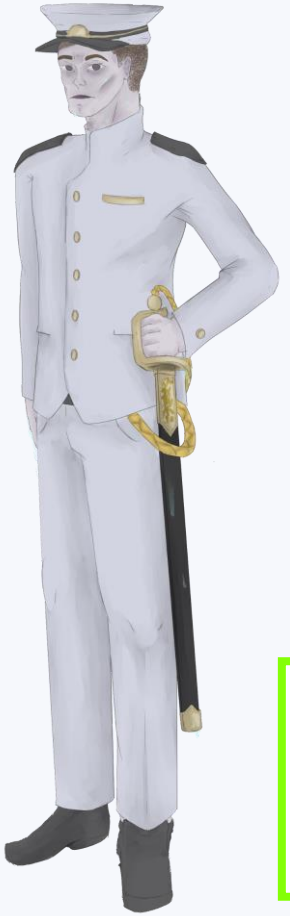
Lactobacillus casei Challenge

Use 3 "Immune System" growth penalty battle cards during the same battle.

Resistances: "Protozoa". "Immune System".

Upgrade47

Legionella pneumophila



L. pneumophila enjoys a symbiotic relationship in a protist biofilm, even when internalised by the larger microbes. Those features make it equally able at surviving macrophages of the immune system when transmitted through consumption or inhalation of contaminated water. Growing in the respiratory tract it can cause severe damage resulting in Legionnaire's disease.

Ability: AMEBOID HOST

On this microbe's first turn coming into play, add one Battle Card with "Protozoa" in its name to your hand from your Battle Card Deck and shuffle the deck.

Whenever a Battle Card with "Protozoa" in its name is played, this microbe gains 1 biofilm growth counter.

Legionella pneumophila Challenge

Win a battle (reaching 15 biofilm growth counters) after using the ability "AMEBOID HOST".