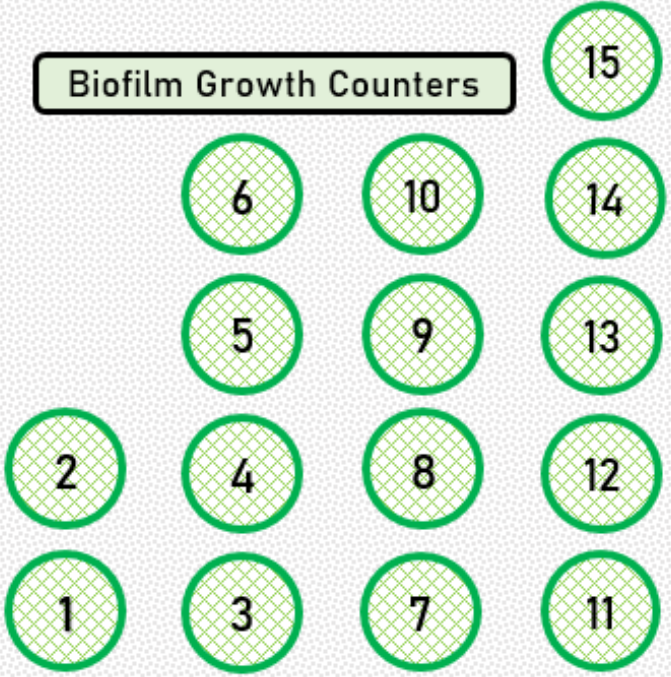
Biofilm Growth Counters



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 card.

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.

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Microbe Zone

Load your microbe into this space for it to grow. Microbes stay in this zone unless moved by other means.

Battle Card Zone

This Zone needs to be free to use Growth Promoting, Growth Penalty or General Active Cards.

Waste Zone

Gene Modification Card Zone

Place up to 1 "Gene Modification" Battle Card at a time here to affect your microbe.

They stay active in this zone until your microbe leaves its "Microbe Zone", They can only be removed by the effect of another battle card, or microbe.

Environment Battle Card Zone

Place "Environment" Battle Cards here. It can only be replaced by a new environment battle card, or removed by another effect.

Battle Card Deck

Place a shuffled deck of Battle Cards face down. There can only be a maximum of 3 of each kind of card and between 25-30 cards.

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

MicroBattle – Soil Microbe Pack

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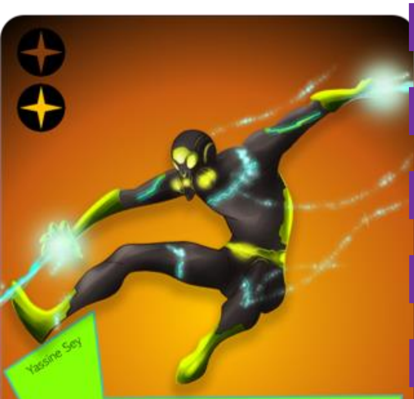
(1) Please trim white excess paper. (2) Fold along Orange Line and glue card backs together. (3) Cut along Purple Lines to separate cards after glue has set.

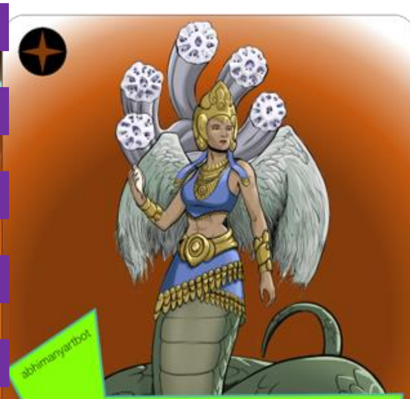
DRAG and DROP microbe and battle card images from the MicroBattle card folder into the respective slots. Distortion of card size may occur, but after cutting and trimming they will be playable.



Geobacter sulfereducens

Resistances: None.

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



Streptomyces coelicolor

Resistances: "Antibiotics".

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.

Salmonella enterica

Resistances: None.

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.

Soil

Effect: Once during your turn, you can send 1 card from your hand to the waste zone and draw one new card from your battle card deck. This card remains on the environment battle card zone, unless replaced by another environment battle card or moved to the waste zone by another effect.

The integrity and viability of Earth's soil is largely dependent on the microbe players as they contribute an important role in all geochemical cycles.

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Manure Fertilizer

Effect: Your microbe with "Soil" in its environment bonus gains 2 biofilm growth counters. For every "Manure Fertilizer" battle card already in the waste zone, add +1 biofilm growth counter. Then send this card to the waste zone.

Decomposing matter is an essential component for a healthy soil and can provide many nutrients and biomass for the microbial population.

Soil-Nitrogen Cycle

Effect: This card can only be played when "Soil" is in your environment battle card zone. This card remains in your battle card zone and once during your turn, your microbe with "Soil" in its environment bonus gains 2 biofilm growth counters. This card occupies your battle card zone and is sent to the waste zone when playing another battle card (growth promoting, penalty, general) in that zone.

The geochemical cycle of nitrogen is essential for life on Earth. Disturbances in the conversion of soil nitrates to atmospheric nitrogen gas can release climate active greenhouse gases.

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Nitrogen Fertilizer

Effect: Your microbe with "Soil" or "Aquatic" in the environment bonus gains 2 biofilm growth counters. Then send this card to the waste zone. If there are 2 other "Nitrogen Fertilizer" cards in your waste zone, add one battle card with "Algal Bloom" or "Soil Nitrogen Cycle" in its name to your hand from your Battle Card deck and shuffle the deck.

Use of nitrogen fertilizers in farming to meet the global food demand sometimes upsets the soil's microbiological balance and can leach into the ground water reservoir and other aquatic environments.

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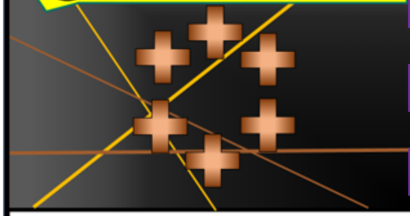
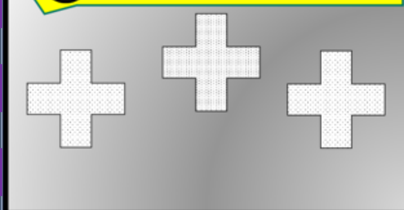
Bioremediation



Effect: You can only activate this card if a microbe with "*Geobacter*" in its name is on your microbe zone and only once per "Battle". Remove all Environment Battle Cards on all fields and your microbe gains 6 growth counters. Then send this card to the waste zone.

Geobacter species bacteria have been used often to clean up oil-spills or clear radioactive contamination. The cleaning in this context is known as bioremediation.

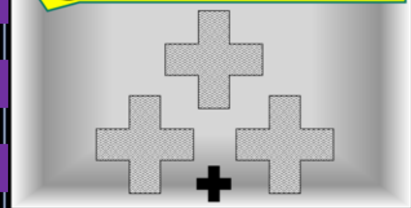
Adhesion Protein



Effect: If your microbe has 3 or less biofilm growth counters, your microbe gains 3 biofilm growth counters. Then send this card to the waste zone.

Microbes can produce glycosylated proteins (coated in sugars) attached to the cell wall to adhere to surfaces and each other. Adhesion is an essential step in biofilm formation.

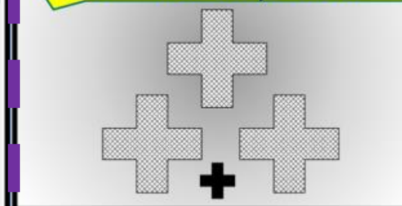
Amino Acids



Effect: Your microbe gains 3 biofilm growth counters, and all opposing microbes gain 1 biofilm growth counter. Then send this card to the waste zone.

Amino acids are the building blocks of all proteins. Most bacteria can produce most of the standard 20 by themselves but harvesting them from the environment can always help.

Carbohydrates



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Carbohydrates are everywhere. Sugars, starches, attached to proteins... They can be an essential source of carbon for microbes.

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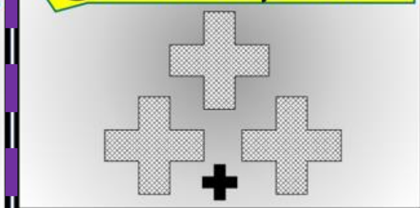

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Antibiotics

Effect: Remove up to 4 biofilm growth counters from all microbes. Then send this card to the waste zone.

Antibiotics refer to a group of drugs that inhibit bacterial growth or kill bacteria. Growing resistance to these molecules by disease causing (pathogenic) bacteria is a growing concern.

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Gene Modification - Resistance

Effect: This card remains in the appropriate battle card zone and is associated with your microbe. When your microbe leaves its zone, this card is moved to the waste zone.
Once during either player's turn in response to a growth penalty (↓) battle card, your microbe loses a maximum of 1 biofilm growth counter.

Genes that provide resistances to anti-microbial compounds or improve survivability can be transferred from microbe to microbe. And so antibiotic resistances are a current health care crisis.

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MicroBattle BATTLE CARD National Biofilms Innovation Centre Quadram Institute MicroBattle Project was funded by the National Biofilms Innovation Centre (NBIC) Public Engagement Grant 2020-2021. (repeated on four further card backs)

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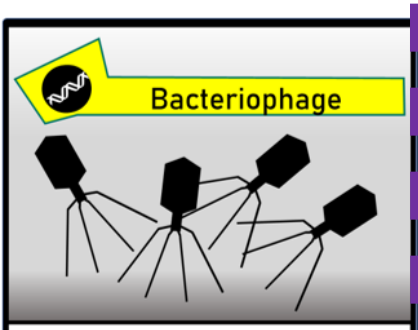
Bacteriophage



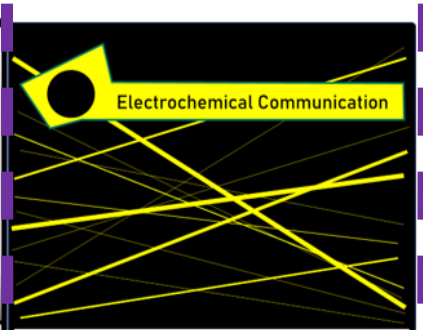
Effect: Choose and apply 1 of these 3 effects:

- Remove 3 biofilm growth counters from all microbes.
- Add 1 "Gene Modification" active card from your battle card deck to your hand. Then shuffle that deck.
- Move 1 of your opponent's "Gene Modification" battle cards to the waste zone. "

Then send this card to the waste zone.

Bacteriophages are viruses that infect bacteria and archaea. They use the host's genetic machinery, and sometimes a bit of the previous host's genomic DNA may get distributed.

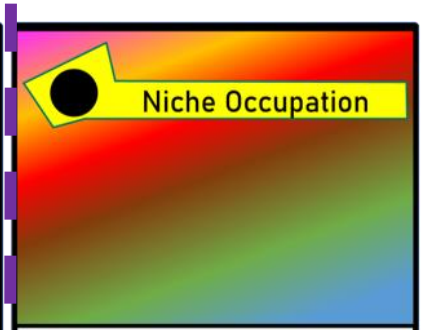
Electrochemical Communication



Effect: Shuffle 1 growth promoting (↑) battle card into your battle card deck. Draw 2 new cards. Then send this card to the waste zone.

Microbes in a biofilm can signal electrochemically similarly to neurons. This can be to respond to external stressors and coordinate nutrient distribution.

Niche Occupation



Effect: Add 1 "Environment Battle Card" from your deck to your hand and shuffle that deck. Then send this card to the waste zone.

Organisms have often evolved to be highly adapted to a particular ecosystem and life cycle.

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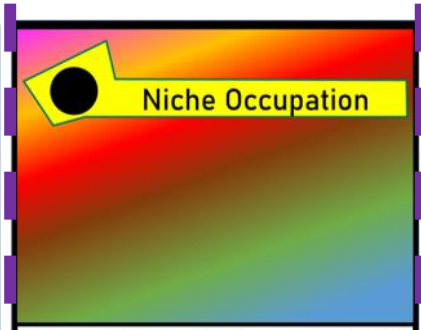

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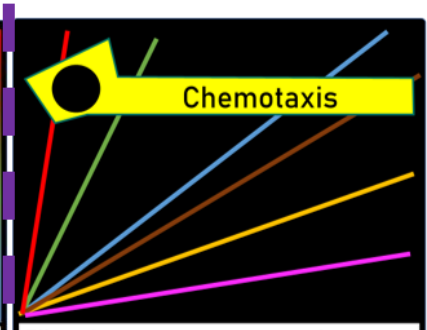
Chemotaxis



Effect: If your microbe is at 3 biofilm growth counters or less, or 13 biofilm growth counters or more, apply the following effect: Draw 1 new card from your Battle Card Deck. Then send this card to the waste zone.

Chemotaxis refers to mobility and navigation in the direction of a molecule of interest (nutrients, signals from other microbes or hosts). Whilst the mature biofilm is static there is movement at the beginning and end of the cycle.

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