

microcosm



60-120



1-4



Ages: 10+

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Artist: Tristam Rossin



Introduction:

Microcosm means “little community.” In this game, you enter the hidden world of beneficial microbes—unseen yet essential players that quietly keep our planet running.

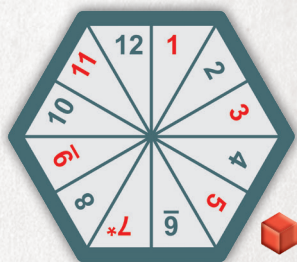
Harness the power of microbes to recycle chemicals through symbiotic interactions. Some relationships are mutually beneficial (*mutualism*), while others advantage one partner without harming the other (*commensalism*), or drive competition for limited resources. By building and managing these connections, you will shape the flow of resources through the environment.

Your goal is to tip the balance of the ecosystem in your favor by maximizing energy gained through chemical recycling. To do this, you will play as environmental microbes working together to complete biogeochemical cycles—the continuous movement of elements between living organisms (plants, animals, and microbes) and the non-living world (air, water, and geological processes).

Four major cycles drive gameplay: carbon, nitrogen, iron, and sulfur. Master their interactions, optimize your microbial network, mutate, and outcompete your opponents to become the most efficient recycler in the microcosm.

Although simplified, the game is based on real scientific ideas from microbiology and ecology. It is designed to help players understand how microscopic interactions can have large-scale effects on ecosystems, and why these tiny organisms are so important for life on Earth.

Components:



Round Tracker & Cube



First Player Marker



12 Biome Tiles



75 Microbe Cards

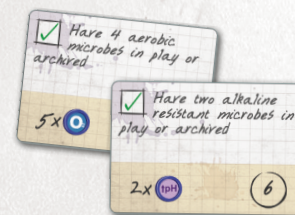


22 Non-Microbial Cards

4 Score Trackers



20 Objective Cards



4 Hand-Size Tokens



Player Markers
(in 4 colors)



100 Mutation Magnetic Clips



120 Resource Tokens
(in 4 colors)

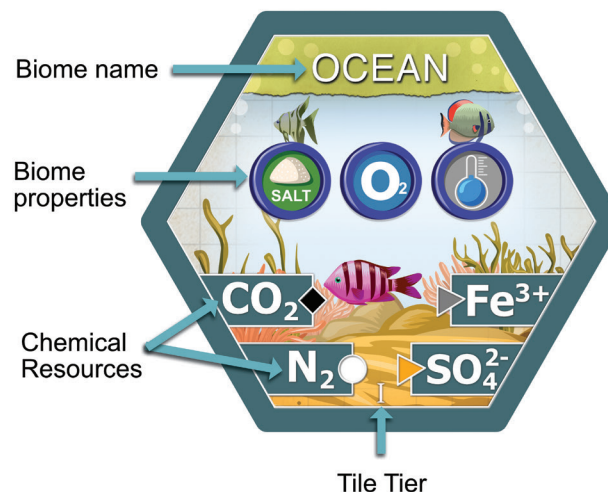
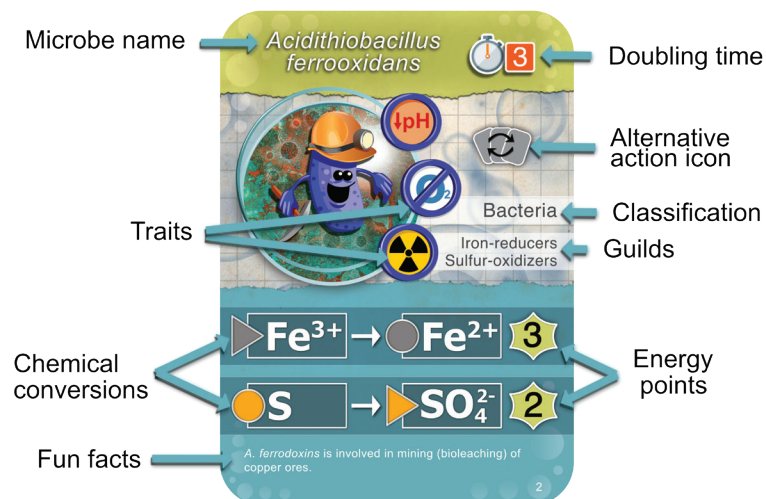


Setup:

Note: If this is your first game or you are playing with younger players you can skip the setup steps marked with . If you would like a shorter version of the game (~1 hr) include the “Quick Game” setup steps

- Put the **round tracker tile** in the middle of the table. (Flip the round tracker to the quick game side.) Beginning at the number 2 on the round tracker lay 3 randomly selected **Tier I** tiles (or 2 for a more challenging version). Then moving clockwise, shuffle and randomly lay **Tier II** tiles to fill in the remaining spots surrounding the round tracker.
- Place the **round tracker cube** on spot 1 of the tracker.
- Place the “**Earth**” **biome tile** to the side of the main board (tile does not come into play until round 7.)
- Shuffle and make a face-up stack containing of the remaining **Tier II** tiles.
- Place **resources** matching the chemical color on each chemical on the biome cards. Yellow for sulfur, clear for nitrogen, silver for iron, and black for carbon.
- Shuffle the **goal cards** and place 3 cards face up near the board. Place the remainder of the goal cards in a stack next to the face up cards.
- Shuffle the **microbe deck** and deal each player 5 cards. Place the remainder in reach of all players.
- Each player takes the **player tokens** of their color, a **player aid/alternative action guide**, **icon guide**, and a **score tracker**.
- Place the **resource pieces** and **mutation magnets** near the board.
- Shuffle the **nonmicrobial deck** and set it aside.
- The first player is the person who most recently looked through a microscope or you may randomly determine the first player and give them the **first player token**.

Anatomy of the Cards and Tiles:



Gameplay Overview:

Gameplay takes place over a number of rounds with the goal of obtaining the most energy points from metabolizing compounds (converting resources) and completing cycles of chemical conversions. "Completing a cycle" involves converting a chemical from the form in the biome to a different form or forms and then back to the original form in the biome.

PLAYER TURN SUMMARY:

1. Primary action:

- Metabolize:** Play a card into a biome, or
- Discard a card for its alternative action

2. Secondary action (optional):

- Quorum sensing:** Discard two cards with matching guilds to take another primary action
- Claim an objective card

3. Replenish: Draw cards up to hand limit +1; discard down to hand limit.

END OF ROUND (after each player has had a turn):

- Doubling time passes:** Remove a player token from each active card. If the last token would be removed instead cover the time symbol with that token.

- Replicate:** resources duplicate if the microbe timer countdown reaches zero.

2. Symbiosis: score completed cycles.

- Evolve or die off:** Chose to either gain a mutation from the environment for 1 card retrieved from a completed cycle or archive the card in your microbe graveyard for end game points equal to doubling time. The remaining cards per player are archived.

- Reset board:** At the beginning of odd numbered rounds, the biome tile next to the red cube is replaced or flipped. Tier I tiles are replaced, and Tier II tiles are flipped. Score any incomplete cycles on replaced tiles.

- First player marker passes counterclockwise.

- Increase the round tracker by 1.

GAME END SUMMARY:

1. The game ends after 12 rounds (6 for the quick game), or after a cycle is completed on the "Earth" biome tile (normal or challenging games only).
2. Final score consists of energy points from the score tracker, objective cards, archived cards equal to the doubling time number, and 1 point per mutation on archived cards in your microbe graveyard. Incomplete cycles score half points. The player with the most points wins.

Gameplay Details:

Each turn players take a primary action and may take an optional secondary action. Then they redraw up to their hand limit (**hand limit is 5 at the start of the game**). Play proceeds to the next player in a clockwise rotation.

PRIMARY ACTION: Play a microbe card into a biome or discard a card for its alternative action.

To play a microbe card into a biome it must be able to survive in that environment according to **three conditions**:

1. The microbe must have the trait to be able to withstand **at least one** of the biome's properties for Tier I and Tier II tiles, both biome properties in Tier III biome tiles. For the Earth tile, microbe cards must have any two matching trait icons. Nonmicrobial cards cannot be played onto the Earth tile.
2. The microbe must be able to obtain the resources it needs to perform a metabolic reaction. Available compounds include those that are on the biome tile or those that are produced (right side of the arrow in the metabolism reaction) by another microbe card. At the beginning only those chemicals on the biome tiles are available.
3. There must be enough space for the microbes to grow. A biome can have a maximum of 2 different cycles in play at the same time. Two of the same chemical cycle cannot be played from a biome simultaneously.



When placing your microbe card into the corresponding biome...

If this is the first card to be played into the biome, place it under the biome tile. If you are playing a microbe card to begin a second cycle in a biome utilizing a different starting resource, place it on the bottom left or right of the tile. A maximum of two resource types can be in play per biome at one time.

If using a resource produced by another microbe card, place your card on top of the card already in play; this card is now the active card. Remove all but one of the player tokens from the bottom card and return to the corresponding player. If the card you are placing will complete a cycle (see Symbiosis for definition of complete cycle) place the card sideways. No more cards can be played off of this card.

Place your replication tokens on the card equal to the doubling time indicated on the card. Check the biome for any time modifiers. If a biome symbol has a -1 time indicated and your card has that matching symbol, place 1 less replication marker on your microbe card. This represents a microbe well adapted to a particular biome.

Metabolize: convert chemical resources.

Move the resource(s) of the color corresponding to your chosen cycle to your microbe card. If the microbe card has multiple reactions of the same color, place the resources on the chemical conversion of your choice. If a microbe card has two conversion that can utilize two different resources from the biome, both may be moved onto the card.

1. If you played directly into the biome tile take the resources from the biome tile.
2. If you played your microbe card onto a cycle that has already started, move the resources from the card above yours in the cycle onto your card.

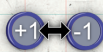
To discard a microbe card for its alternative action see the icon explanations below:



Increase your hand size limit by 1 (max once per game).



Replace an opponent's card with your own. Must have the same chemical conversion. The opponent archives their card.



Horizontal gene transfer: Move a mutation from one microbe card in your hand to another.



Block an opponent's card from doubling. Cover the doubling time marker on their card with their token.



Discard up to 3 cards from your hand and redraw up to your hand limit.



Discard 2 cards from the available objectives; redraw 2 objective cards.



Reduce the doubling time of one of your cards by 1. (i.e. remove a player marker from the card).



Use a card of your choice from the nonmicrobial deck. Look through the deck and choose a card to play on a valid location (i.e. the chemical on the left side of the arrow matches a chemical on the main board).



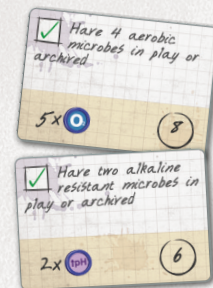
Archive a card by placing it into your microbe graveyard.



SECONDARY ACTION: Players *may* take one of these secondary actions (optional, for normal and challenging games only)

Quorum sensing: Discard 2 cards with matching guilds to take another primary or secondary action (max once per turn). Only one guild on each card needs to match.

Claim an objective card: If a player completes the requirements for one of the available objectives, that player claims the objective card for points at the end of the game (max once per turn). Tags on mutations count towards claiming objectives. A new goal card is drawn immediately from the goal deck and placed face up to replace the claimed card.



REPLENISH: Draw cards up to hand limit +1. Discard down to hand limit (players begin with a hand limit of 5).



Environmental Collapse

If the number of same-colored resources on a card or a tile ever reaches 16, it immediately triggers environmental collapse. Remove the tile and all cards on that tile from the game. Cards are not archived or scored and do not pick up mutations. Replace the tile with the top tile on the reserve stack. This represents the environment reaching its carrying capacity and is unable to support a larger population.

End of Round

After all players have taken a turn, proceed with the following:

1. DOUBLING TIME PASSES: This represents the time it takes for microbes to grow and multiply exponentially. During this stage the doubling time counter will count down towards zero, at which point resources on that card double. Strategic growth is key, if resources on a card reach 16, the biome reaches its carrying capacity.

- Remove a player token from each active card. If the last token would be removed (i.e. doubling time reaches zero), instead cover the doubling time symbol with that player's token and proceed to replication. A card with a covered time symbol can no longer replicate.
- Replication: Double the resources on the cards when the doubling timer has reached zero.



Example:

In round 1, **Ted** played a card and converted SO_4^{2-} to H_2S . No one played on his card for two rounds and the resources doubled. In round 3, Ted played a second card converting H_2S to S . Then **Sue** completed the cycle by converting H_2S back to SO_4^{2-} , matching the chemical form in the environment.

Each player scores the number of resources at the end of the cycle x the energy points on the chemical conversion used.

Ted scores $(2 \times 2) + (2 \times 2) = 8$
Sue scores 4

2. SYMBIOSIS: A cycle is complete when the final card produces the same chemical compound that was present in the biome for a particular cycle. For example, if you play a card into a biome containing CO_2 and the card converts CO_2 to C, a second card converting C to CO_2 would complete the cycle. When a cycle is completed, the card should be turned 90 degrees.

To score a complete cycle, multiply the number of resources on the final card by the energy point number corresponding to the reaction used on each card involved in the cycle. All players with cards in play in the cycle score points. Track your score with the score tracker. **Return all resources** from the completed cycle back to the biome tile. Return each microbe card to the corresponding player, who will then choose whether to allow their microbe(s) to evolve or die off.



Evolve or Die Off:

- Evolve:** Mutate your card by picking up a mutation from the environment and placing the card back in your hand. To pick up a new mutation, add the mutation magnetic clip with a corresponding symbol to your card. (It is recommended to clip the magnets onto the plastic card sleeves provided). Only traits that correspond to properties of the biome from which the microbe card was retrieved can be picked up through evolution. These traits can be duplicates of ones already existing on your card. A maximum of 2 mutations is allowed per card. If the maximum is reached, new traits may be added if older ones are discarded.
- Die Off:** If you decide to allow your microbe to die off you can archive your card and earn points at the end of the game. To archive a card, place it in your “microbe graveyard” (personal archive pile). Cards in your microbe graveyard will be worth energy points equal to the doubling time value on each card at the end of the game.

3. RESET BOARD (at the beginning of odd rounds)

Remove the tile adjacent to the red cube on the round tracker. If it is a Tier I tile, replace with a tile from the stack. If it is a Tier II tile, flip the tile over.

Remove any resources from the removed tile. Place starting resources on the new biome tiles as described in setup.

If in-play cards need to be removed, score those incomplete cycles for half of the points you would normally score.

Pass the first player marker counterclockwise to the next player (in a 2-player game, do not move the first player marker).

Increase the round tracker by 1.



At the start of round 7, the Earth biome tile comes into play.

Game End:

The game ends at the end of the 12th round (▶▶ 6th round in a quick game) or if a cycle is completed on the Earth biome tile. If the latter is true, players who have not yet had a turn this round will finish the round. Players will then tally their scores.

1. **Score complete cycles.** Return cards to each player to be placed in their microbe graveyards.
2. **Score incomplete cycles** on the board using the same method described in “Symbiosis” and divide that score by two. Cards do not return players.
3. **Count the number of energy points** you have on your score marker, plus the doubling time number of each card in your microbe graveyard, and the points on the objective cards.

The winner is the person with the most energy points! In the case of a tie, the player with the most collected mutations on any card in play, in hand, or in graveyard wins.



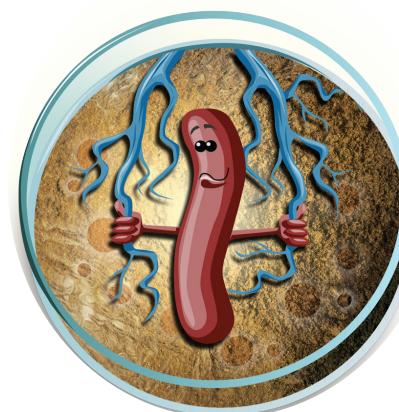
Solo Mode:



In solo mode, you play against the nonmicrobial components of the environment. Setup and play according to the rules of a normal game but with one addition. After you take your turn, draw a card from the nonmicrobial deck. Play that card in the first valid location on a biome or a card starting at the tile to the left (counterclockwise) of the round marker and moving counterclockwise. (i.e. the chemical on the left side of the arrow matches a chemical on a biome or the product/right side of a reaction used on an active card). If there are no valid locations, discard that card and draw another card from the nonmicrobial deck and repeat. Pick a color for the nonmicrobial deck automata, use those player tokens to mark the doubling time counter for those cards. If a card has the nonmicrobial deck icon as its alternative action, you cannot use it for its alternative action in this mode.

Two Player Mode With Automata Variation:

This is an optional two-player mode playing with the nonmicrobial deck as the **automata**. Follow the directions for a normal game and add the instructions from solo mode using the automata as the third player.



The Science Behind Microcosm

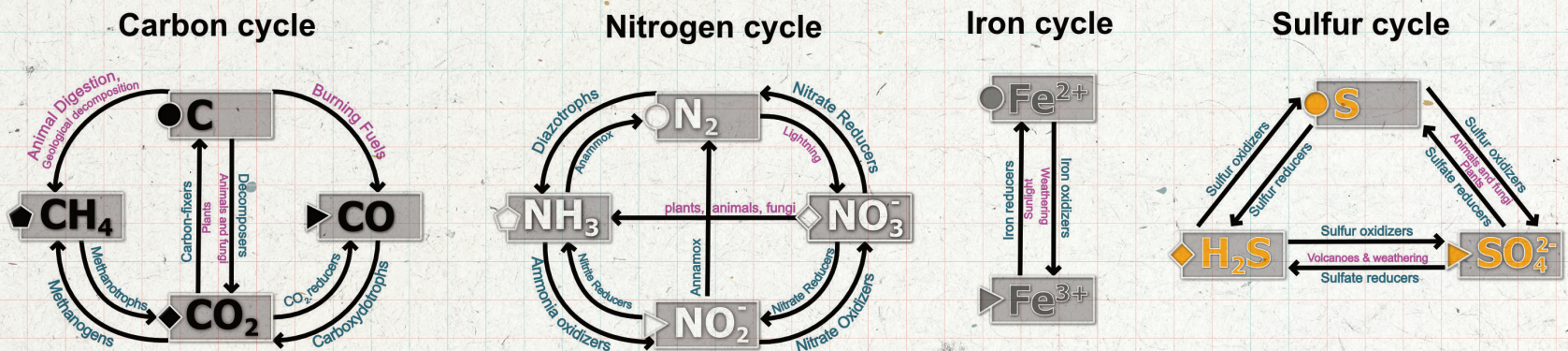


About the Science:

The world is filled with microscopic life forms, bacteria, archaea, and eukaryotes, that are too small to see but essential for life on Earth. These microorganisms make up what scientists often call the “microcosm,” a hidden community that carries out many of the chemical processes that keep ecosystems running.

One of the most important roles of microbes is recycling essential elements between biotic (living) and abiotic (nonliving) components in the environment through a process called biogeochemical cycling. Through their metabolism (the chemical reactions that allow organisms to live and grow), microbes break down organic matter and convert chemicals into forms that other organisms can use. Abiotic factors like pollution, volcanoes, and geochemical processes also contribute to chemical cycling in the environment.

Breaking down chemicals through metabolism releases energy. Certain types of metabolism release more energy than others, which is represented in this game by energy points. The doubling time counter and resource duplication represents microbial exponential growth. Microbes replicate by creating two identical copies of themselves, so cells multiply exponentially after several generations of growth.



The diagrams above illustrate the biogeochemical cycles represented in this game. Blue text represents microbial processes (microbial deck), and pink text represents other environmental processes (nonmicrobial deck).

Life on Earth depends on a continuous recycling of essential elements through the environment, living organisms, and the atmosphere. These biogeochemical cycles help sustain ecosystems by moving nutrients and compounds through natural processes that connect microbes, plants, animals, air, water, and soil.

Carbon Cycle: In the carbon cycle, plants and microbes fix carbon dioxide from the atmosphere into an organic form of carbon. Decomposers then break down dead organic material, returning carbon dioxide to the atmosphere. Carbon forms the backbone of most molecules in living organisms. Other pathways include animals releasing methane during digestion, which is further processed by microbes, and microbes converting toxic carbon monoxide from fuel combustion into less harmful compounds.

Nitrogen Cycle: In the nitrogen cycle, microbes help to transform nitrogen from the atmosphere into fertilizer for plants. Animals obtain this nitrogen by eating plants, incorporating it into proteins and DNA. When organisms produce waste or die, microbes recycle nitrogen back into the environment.

Iron Cycle: Iron cycles through an oxidized (such as rust) and reduced form. It is released into the soil and waterways through rock weathering and cycled by microbes. Iron is an essential micronutrient for chlorophyll production in plants and hemoglobin in animals, the protein that transports oxygen in blood and gives it a red color.

Sulfur Cycle: Sulfur is released into the atmosphere by geochemical processes like volcano eruptions. Microbes convert sulfur into forms that can be taken up by plants to build proteins and continue the cycle through the food web.

If you are interested in learning more about biogeochemical cycling please check out our website, microcosm-games.com. You'll find a Teacher's guide with lesson plans and slides to incorporate this game into the curriculum at the middle school, high school, and college levels.



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Special Thanks To
Our Family, Friends, and all of
our Playtests and Backers!



Gameplay Notes

- If you run out of mutation markers, they can be removed from archived cards. Add those points to the score counter (1 per mutation).
- “Carbon” is represented by the black resource cubes and refers to any chemical containing carbon (i.e. CO_2 , CO , C , or CH_4).
- “Nitrogen” is represented by the clear resource cubes and refers to any chemical containing nitrogen (i.e. N_2 , NO_2^- , NO_3^- , or NH_3).
- “Iron” is represented by the silver resource cubes and refers to any chemical containing Iron (i.e. Fe^{2+} or Fe^{3+}).
- “Sulfur” is represented by the yellow resource cubes and refers to any chemical containing sulfur (i.e. SO_4^{2-} , H_2S , S).

Glossary of Terms

Active cards: The last card in a cycle.

Archive: Place a microbe card in your personal archive deck, the “microbe graveyard”.

Carrying Capacity: The maximum population size that an environment can support.

Chemical equation: The representation of a chemical reaction (resource conversion) with an arrow pointing from the required reactants to the products.

Cycle: refers to the biochemical cycle of one major element (C, N, S, or Fe). Converting this element through different chemical compound forms and back to its original form, e.g. $\text{N}_2 \rightarrow \text{NH}_3 \rightarrow \text{NO}_2^- \rightarrow \text{NO}_3^- \rightarrow \text{N}_2$.

Discard: Place a microbe card in a general discard pile face up.

Doubling time: the time it takes for a microorganism to complete one cycle of replication, splitting into 2 daughter cells. Also called generation time.

Energy Points: Energy spent or received by conducting a chemical reaction. Energy points = victory points.

Horizontal gene transfer: The transfer of genes between two organisms that are not parent and offspring.

Metabolism: Converting one chemical compound to another, releasing or consuming energy points.

Mutant: A microbe that has acquired a trait through evolution.

Properties: Biome physical characteristics.

Quorum sensing: A type of communication that allows microbes to coordinate actions when they reach a certain population threshold.

Replication: The duplication of a microorganism, producing two identical cells.

Resources: Chemical compounds, can refer to either the reactants or products of a reaction. Can also refer to chemical compounds available from biomes.

Traits: Microbe characteristics that correspond to biome properties.

