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| **Volutin Granules** | **Anaerobic Respiration** | **Mitochondria** |
| Develop inclusions within the cytoplasm which store glycogen and starches for use in energy generation | Develop ability to rapidly produce small amounts of cellular energy without breaking down oxygen molecules | Develop ‘cell battery’ which breaks down nutrients into energy rich molecules through aerobic respiration |
| +1 energy | +2 energy | +3 energy |
| **Costs 1 energy units** | **Costs 2 energy units** | **Costs 3 energy units** |
| **Binary Fission** | **Intracellular Offspring** | **Cytoplasmic Fission** |
| Develop ability to duplicate genetic material and separate the copies to create an identical replica cell | Develop ability to copy genetic material asymmetrically to create one larger cell and a smaller offspring cell | Develop ability to copy genetic material several times before cell division to create multiple offspring cells at once |
| +1 reproduction | +2 reproduction | +3 reproduction |
| **Costs 1 energy units** | **Costs 2 energy units** | **Costs 3 energy units** |
| **Chemoreceptors** | **Facilitated Diffusion** | **Plasmids** |
| Develop molecular receptors which are able to detect external changes in chemical concentrations | Develop molecular channels which transfer and exchange chemicals across the cell membrane | Develop plasmid rings which store extra chromosomal DNA to transfer beneficial traits across cells |
| +1 intelligence | +2 intelligence | +3 intelligence |
| **Costs 1 energy units** | **Costs 2 energy units** | **Costs 3 energy units** |

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| **Enzyme Release** | **Enveloping Membrane** | **RNA Virus** |
| Develop ability to release enzymes which can break down the membranes of adjacent cells | Develop a membrane which can envelope other cells and digest the contents through the release of enzymes | Develop RNA virus which can replicate itself within other cells and ultimately cause the host cell to die |
| +1 attack | +2 attack | +3 attack |
| **Costs 1 energy units** | **Costs 2 energy units** | **Costs 3 energy units** |
| **Plasma Membrane** | **Multilayer Membrane** | **Cell Well** |
| Develop a phospholipid bilayer which protects the cytoplasm by controlling the entry of substances | Develop a thick, multi-layered membrane which provides greater control of substances entering the cell | Develop a rigid and impermeable cell wall which envelopes the membrane and provides high levels of protection |
| +1 defence | +2 defence | +3 defence |
| **Costs 1 energy units** | **Costs 2 energy units** | **Costs 3 energy units** |
| **Slime Layer** | **Rotating Flagellum** | **Whip-like Flagellum** |
| Develop layer of loose, unorganised extracellular material that surrounds the cell to facilitate movement | Develop elongated filaments on the cell membrane which rotate in a propeller like motion to provide mobility | Develop elongated filaments on the cell membrane which beat back and forth to provide rapid mobility |
| +1 mobility | +2 mobility | +3 mobility |
| **Costs 1 energy units** | **Costs 2 energy units** | **Costs 3 energy units** |

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| **Toxin Breakdown** | **Cellular Spines** | **Primitive Eye** |
| Divert energy to the breakdown of toxins which increases defence but lowers energy production | Use energy to build hardened layers of proteins on the cell membrane to increase attack and defence | Evolve light sensitive cells which increase responsiveness to the environment but slow reproduction |
| +2 defence  -1 energy | +2 defence  +2 attack  -2 energy | +3 mobility  +3 intelligence  -3 reproduction |
| **Costs 1 energy units** | **Costs 2 energy units** | **Costs 3 energy units** |
| **Active Transport** | **Glycocalyx Capsule** | **Primitive Mouth** |
| Use proteins in cell membrane for energy transfer to allow energy absorption against a concentration gradient | Evolve a glycocalyx layer which allows cells to adhere to surfaces and form biofilms (colonies of microbes) | Evolve a mouth-like orifice which can absorb external energy and damage other cells but slows reproduction |
| +3 energy  -2 attack | +2 defence  +3 intelligence  -3 mobility | +2 attack  +3 energy  -2 reproduction |
| **Costs 1 energy units** | **Costs 2 energy units** | **Costs 3 energy units** |
| **Gas Filled Inclusions** | **Pili** | **Conjugation** |
| Use proteins from the cell membrane to assemble gas filled vesicles in the cytoplasm which allow control of cell buoyancy. | Use energy to build filaments which attach to cells for colonisation and transfer DNA to friendly cells | Lower defences to allow cell to cell transfer of genetic material through conjugation tubes |
| +3 mobility  -2 defence | +2 attack  +2 reproduction  -2 energy | +4 reproduction  -1 defence |
| **Costs 1 energy units** | **Costs 2 energy units** | **Costs 3 energy units** |

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| **Endospores** | **Decomposition** | **Cyanobacteria** |
| Transform into dormant endospores during harsh environments and germinate when conditions improve | Secrete specially adapted enzymes which break down cells into simple molecules that can be absorbed | Absorb energy from sunlight to drive photosynthesis in specifically adapted thylakoids |
| Cell survives harsh environments although reproduction falls to 0 | Gain energy from cells which have been successfully attacked | Continuous energy source means all energy costs are halved |
| **Costs 10 energy units** | **Costs 10 energy units** | **Costs 10 energy units** |
| **Viral Replication** | **Flexible Reproduction** | **Heat Exchange** |
| Release virus particles when encountering other cells which use the hosts to replicate the DNA of the original cell | Take advantage of favourable external conditions by increasing reproduction rates when O2 levels are high | Exchange heat within clusters of cells to regulate temperature and allow survival in extreme conditions |
| If attack overcomes a cell’s defence the losing cell becomes a replica | Reproduction rate increases in line with atmospheric O2 level | Cells in groups of 5 or more survive in all temperatures |
| **Costs 10 energy units** | **Costs 10 energy units** | **Costs 10 energy units** |
| **Chemical Defence** | **Germination** | **Speciation** |
| Release specialised chemical signals which detect presence of offensive cells before being attacked | Create back-up copy of cells genetic material in a protected plasmid which can be stored externally | Divide cells into distinct spatial areas leading to phyletic evolution and formation of a new species |
| Allow peremptory mobility action before being attacked | Cell regenerates somewhere on the board after being killed | Select an additional species card to start a second organism |
| **Costs 10 energy units** | **Costs 10 energy units** | **Costs 10 energy units** |

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| **Oxygen Release** | **Thermal Power** | **Multicellular Organism** |
| Coordinate release of oxygen as cell by-product to raise atmospheric O2 levels by 1% each evolution | Release thermal energy through coordinated energy generation raising temperature by 1 degree each evolution | Fuse cells together to create a multicellular organism opens up a new era of evolution and ends the game |
| Requires a minimum intelligence of 5 and at least 5 cells | Requires a minimum intelligence of 5 and at least 5 cells | Requires a minimum intelligence of 5 and at least 5 cells |
| **Costs 15 energy units** | **Costs 15 energy units** | **Costs 15 energy units** |
| **Cthulu**  **God of War**    1 point per attack | **Ganesha**  **God of Wisdom**    1 point per intelligence | **Pan**  **God of Music & Dance**    1 point per mobility |
| **Pele**  **Goddess of Lightning**    1 point per energy | **Xochiquetzal**  **Goddess of Fertility**    1 point per reproduction | **Bast**  **Goddess of Protection**    1 point per defence |
| **Virus Outbreak**  A contagious virus spreads rapidly across the globe causing the death of all organisms with a defence lower than two | **Meteor Strike**  A comet falls to earth bringing complex organic life forms which kill off all cells with an attack lower than two | **Thermal Vent**  A chasm releases massive amounts of heat killing all cells which can’t break it down with an energy score less than two |
| **Virus Outbreak**  A virus emerges leading adjacent cells to develop immune response systems which cause cells’ defence to increase by 5 | **Meteor Strike**  A comet falls to earth bringing complex organic life which cause adjacent cells’ attack to increase by 5 in response to the threat | **Thermal Vent**  A chasm opens up in the seabed releasing heat energy which causes adjacent cells’ energy production to increase by 5 |
| **Volcanic Eruption**  A volcanic eruption generates a thick cloud of ash which causes the loss of lifeforms with an intelligence less than 2 which cannot adapt | **Glacier Age**  A reduction in solar activity leads to a massive glaciation event which causes cells with mobility less than 2 to die | **Ozone Layer**  A tear in the ozone layer leads to plummeting oxygen levels which kills all cells with reproduction levels lower than 2 |

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| **Volcanic Eruption**  A volcanic eruption generates a thick cloud of ash which forces adjacent cells to increase intelligence by 5 to adapt | **Glacier Age**  A thawing glacier leads to temperatures rising which causes adjacent cells mobility to increase by 5 as they thrive in the new conditions | **Ozone Layer**  Repair of a hole in the ozone layer leads to a locailised increase in oxygen which causes adjacent cells’ reproduction to rise by 5 |
| 1st |  |  |
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**Organism Sheet**

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| --- | --- | --- |
| Attack score | Defence score | Reproduction score |
| Energy score | Mobility score | Intelligence score |

Energy units:

Special characteristics:

BOARD

* Grid of empty squares (for now all ocean)
* Temperature gauge shows temperature – habitable zone is -40 to +40 degrees unless organism is specially adapted – starting value is 1 degrees
* Oxygen levels show oxygen concentration in atmosphere – habitable zone is anything above 0% unless organism is specially adapted – starting value is 1%

ORGANISM SHEET

* Score card shows the extent of the organism’s attributes across 6 criteria
* Energy units shows the units of energy available for use by organism
* Special characteristics shows any strategic advantages possessed by organism

TURN ORDER CARD

* Indicates the player who moves first each turn

EVOLUTION CARDS

* Tier 1 – allow the user to evolve simple organism benefits
* Tier 2 – allow the user to evolve but with both costs and benefits
* Tier 3 – allow the user to evolve strategic advantages

ACTION CARDS

* Allow the user to manipulate environmental conditions to favour different types of organism

ENVIRONMENTAL CHANGE CARDS

* Generate significant external changes to environmental conditions – positive and negative

DEITY CARDS

* Deities award points at the end of the game based on units of energy sacrificed

DICE

* Used for attacking and defending as well as for allocating Environmental Change Cards

INSTRUCTIONS

* Shuffle the Evolution Cards and place 3 cards face up, place the rest face down in a pile next to the 3 face up cards.
* Place the 3 Action Cards face up next to the 3 face up Evolution cards.
* Place all 6 God cards face up.
* Shuffle the Environmental Change Cards and place into two piles (negative and positive).
* Each player rolls a die and the highest number is awarded the Turn Order Card, if there is a tie the dice are rolled again.
* The player with the Turn Order Card then rolls two dice. The first number rolled corresponds to the number of negative Environmental Change Cards to be added to the board while the second number corresponds to the number of positive cards. The player with the Turn Order Card then places an Environmental Change Card on a square on the board of their choice. This can be indicated on the board with a skull (negative) or star (positive). Players in a clockwise direction then follow suit until the required number of cards are placed on the board.
* Each player is given an Organism Sheet. The temperature begins at 1 degrees and the oxygen levels begin at 1%. The player with the Turn Order Card selects a place on the board for their organism to begin (for now this can be done by pencilling initials). The remaining players follow suit in a clockwise direction. Organisms cannot be placed within 5 squares of an Environmental Change Card.
* The game then begins and each turn proceeds as follows, with the player holding the Turn Order Card taking the first go for each step and the other players following suit in a clockwise direction:
  + **Step 1: Move**. Each player can choose to expend energy to move their organism. Each unit of energy allows the player to move one of their cells by 1 space on the board. The user can move as many spaces as they have mobility points. Movement allows the user to: (1) escape predators; (2) attack other organisms; (3) seek out new habitats; and (4) activate Environmental Change Cards. If an organism lands on a space on the board occupied by another organism a battle occurs. In a battle the attacker roles dice equivalent to the number of attack points their organism possesses. The defender roles dice equivalent to the number of defence points. If the score rolled by the attacker is higher than the defender the defender cell is removed from the board and is replaced by the attacking cell. If the defending dice score is higher both cells remain where they were before the battle. If the defending cell has attack points greater than zero they then take a turns to attack the attacking cell. If an organism lands on a space with an Environmental Change Card the player must turn over the top card from the pile.
  + **Step 2: Reproduce**. Each player can choose to expend energy to reproduce their organism. Each unit of energy allows the player one additional cell which they can choose to place on an adjacent square to their existing organism. If an organism reproduces onto a rival organism a battle commences. Cell locations must be selected prior to any battles commencing and cannot be put on the same square. The user can add as many cells as they have reproduction points.
  + **Step 3: Evolve**. Each player can choose to expend energy to evolve their organism. Any of the face-up Evolve or Action Cards can be selected so long as the conditions are met and they have the required amount of energy. Only one card can be selected per turn. The changes to the organism resulting from the evolution are then added to the Organism Sheet and take effect in the next turn. If a card is selected and the attribute falls below zero this is recorded on the Organism Sheet. If the energy attribute falls below zero then the corresponding number of energy units the organism receives each turn is reduced by this amount (note, if the score exceeds the amount of energy then the organism receives zero energy. The same is the case for reproduction. For mobility, attack, defence, intelligence the organism is not allowed to use any of these abilities until the score becomes positive again. Once a card is selected it is replaced with the card from the top of the pile so that there are always three face up cards.
  + **Step 4: Sacrifice**. Each player can choose to expend energy to offer a sacrifice to the deities. The number of energy units scarified is placed on the selected Deity Card. There is no cap on the amount of energy that can be sacrificed. If there is already energy on a card the player can remove it and place their energy on the card so long as the sacrifice is of greater magnitude. The removed energy is not returned to the player who undertook the original sacrifice but goes back into the central pot. At the end of the game, the player with the most energy on a Deity Card is awarded the benefits provided by that Deity.
* At the end of the four steps the number of energy units is calculated for each organism and the players are awarded the corresponding energy units, the Turn Order Card moves to the next player, and the turn begins again. Each cell on the board generates one unit of energy plus any energy points the organism has. If no Evolution Cards were selected then they are replaced with three new face up cards form the pack.
* The game ends when: (1) only one organism is left standing; (2) the entire board is occupied by organisms; or (3) the multicellular organism Action Card is selected by a player. At this point each cell on the Board is assigned a score of 1 point. Points are then assigned to any Deity Cards which have been activated. The player with the most points wins the game.