Hands-on DNA: *Bacterial Evolution* – Bacterial Evolution Game

Aim

Be the player with the most bacteria at the end of the game.

Set up

Each group of four players will need:

- Mutation spinner
- Dice
- Counters – large and small
- Mutation cards – positive, negative, neutral and antibiotic resistance
- Chance cards – set of 8

Counters – each player should choose a colour and select 10 small counters (1 bacterium) and 10 large counters (10 bacteria) of that colour.

Mutation cards – sort into piles and place on the table.

Chance cards – shuffle and place *face down* on the table.

Gameplay

❖ Each player starts the game with one counter (bacterium) of their chosen colour.

Each round has three phases:

1. **Mutation** Spin the spinner to decide your mutation type
2. **Reproduction** Multiply your bacteria
3. **Environmental Factors** One player rolls the dice to decide whether you draw a chance card

Phase 1: Mutation

- Each player spins the spinner:
    - Red = negative mutation
    - White = neutral mutation
    - Green = positive mutation
    - Purple = antibiotic resistance
- Take the appropriate card – it will tell you what effect the mutation has on your future growth.
- Once you have a mutation, you keep it and its effect on your growth rate for all following turns, unless you get another mutation…
- The effects of positive and negative mutations cancel each other out, so if you have one of each, your growth rate returns to normal.
- A neutral mutation has no effect on an existing positive or negative mutation, neither does antibiotic resistance which can be held in addition to the other kinds of mutation.
- If you have more than one of either kind of mutation there's no extra effect on your growth rate, but it becomes harder for the mutations to be cancelled out (giving you more of an advantage or disadvantage, depending on the mutation type)

Phase 2: Reproduction

- ❖ All players increase their bacterial populations, according to their mutation status

Neutral mutation: Normal growth, 2x

If you have 4 bacteria, they increase to 8 bacteria (all of your bacteria reproduce).

Negative mutation: Reduced growth, 1.5x

If you have 4 bacteria, they increase to 6 bacteria (only half of your bacteria reproduce).

Always round down – if you have 7 bacteria, they increase to 10 bacteria ($7 \div 2 = 3.5 = 3$ rounded down).

If you get a negative mutation right at the start when you only have one bacterium, miss one turn, then grow by one bacterium next turn (if you still have a negative mutation).

Positive mutation: Increased growth, 2.5x

If you have 4 bacteria, they increase to 10 bacteria (half of your bacteria reproduce a second time).

Again, always round down – if you have 7 bacteria, they increase to 17 (double to 14, add half original = 3.5 = 3 rounded down).

Antibiotic resistance mutation: Has no effect on growth, reproduce as for neutral mutation, 2x

❖ As bacterial numbers increase, use large counters to represent ten bacteria.

Phase 3: Environmental Factors

One player rolls the dice – if 4, 5 or 6 is rolled, a chance card is taken from the top of the pack.

If 1, 2 or 3 is rolled, no card is drawn and the next round begins.

Chance cards:

- Antibiotic treatment: All players back to 1 bacterium, except those with an antibiotic resistance mutation
- Other infection: all players get a bonus phase of 2x reproduction, regardless of their mutations
- Broad Spectrum Antibiotic treatment: Game Over
- Vaccination: Game over

Ending the game

The game will end if the 'Vaccination' or 'Broad spectrum antibiotic treatment' chance cards are drawn, or if desired, the game can be limited to a maximum time or number of rounds.

The winner is the player with the most bacteria at the end of the game.