CODON CLASH

Codon Clash is a serious tabletop game designed to teach and reinforce core concepts of molecular biology through competitive, interactive play. At its heart is the central dogma of biology: information flows from nucleotide sequences to amino acids, three bases at a time (1). Rather than presenting this as static information on a chart, the game turns codons into tangible, manipulable features and amino acids into objectives to find. Players build, extend and disrupt RNA sequences in order to discard their amino acid cards before their opponents. In doing so, they repeatedly practice decoding RNA triplets, recognising alternative codons for the same amino acid and understanding the special role of stop codons in terminating translation.

Learning Outcomes:

Using Blooms taxonomy, the primary learning outcomes operate at the levels of understanding, application and analysis (2).

By the end of a play session, players should be able to:

- Correctly match RNA codons to their corresponding amino acids.
- Recognise that several different codons a encode the same amino acid.
- Identify stop codons and explain their role in terminating a growing protein chain.

These learning outcomes are supported by both the components and the rules of the game. Amino acid cards display their valid codons meaning players are constantly cross-referencing and internalising the information. Codons are drawn, played claimed, stolen and often wasted meaning the players are exposed to the same mappings in multiple contexts rather than as one-off answers. Degeneracy is a key characteristic of the genetic code, it means that each amino acid can be encoded by more than one triplet of RNA nucleotides (3). Each amino acid card presents all options for the encoding triplets, making degeneracy visibly during play. Stop codons are given a disruptive effect in the game, and their biological function is reinforced through a significant consequence, halting game play and altering the order of turns.

A secondary set of learning outcomes targets transferable skills. Players must pay attention to what others reveal, remember hints that are spoken aloud and predict what opponent may be trying to claim next. This supports and enhances communication between players, inference skills and strategic planning even under uninformed conditions.

Design Choices and Educational Use:

The most important design decision was to make codons physical, discrete counters that can be arranged to form different sequences on the table. Players create public RNA chains that everyone can see growing. This reduces cognitive load and allows players to focus on interpretation and strategy rather than memorisation.

Each turn follows a simple rhythm. A player can either: draw an RNA codon counter and add it to the start of their sequence, giving a verbal hint about one amino acid they hold, or they can play the first three codons in their sequence. If nobody claims the codon played, the active player draws a counter from the bag and can ‘mutate’ their own sequence by adding it in at any chosen position. There is tension and interaction throughout gameplay as players build but also intercept and examine the behaviour of others.

The structure of the game forces repeated retrieval and use of codon knowledge. A player who wants to protect their own future claims must notice when opponents accidentally reveal useful codons, and they should stay alert to recognise when a visible triplet matches one of their cards. Correct matching is practiced under light time pressure and social competition as once players have moved on, there is no going back. These conditions most likely to strengthen retention of knowledge compared to passive methods of study (4).

Codons, amino acid names and hints are spoken aloud throughout play, creating auditory as well as visual reinforcement. This is both an accessibility choice as well as a learning mechanism, as hearing names and details spoken aloud caters for different learning styles and ensure visually impaired players are not disadvantaged.

Stop Codons:

In biology, stop codons terminate translation (5). During Codon Clash, playing a stop codon halts the normal turn order and grants the stop card holder an extra turn. This interruption mirrors biological termination by creating a dramatic momentum swing, but is adjusted to not halt game play entirely. Players will the function of stop codons as they will have felt their impact on the flow of the game.

Luck or Skill?

Codons are drawn randomly throughout the game, meaning chance influences the available play options. However, winning depends on recognising patterns, timing play, interpreting and recognising opponents hints and ability to associate amino acids with their corresponding codons. Players cannot rely on luck alone as they must correctly decode visible RNA triplets and decide when to risk playing them. The randomised draw system keeps the game accessible to beginners while the interception and prediction elements reward growing scientific knowledge.

This balance ensures that less experienced players can still participate meaningfully while more knowledgeable players gain a strategic edge without becoming unbeatable. This encourages repeated play, allowing players to master genetic translation over time.

Accessibility and Inclusivity of Design:

The physical components of the game were designed to be readable and usable by as many people as possible. All codons and amino acids are read aloud as they are played, ensuring information is available to players who may struggle with sight r small printed text. The rule that sequences should not exceed ten counters prevents the table state from being overwhelming whilst also ensuring counters do not run out during game play. Nucleotides were colour coded with colour-blind friendly (6), easily distinguishable colours, enabling quick recognition to maintain the pace and excitement of the game.

All text is formatted clearly, with cards featuring a minimalistic, non-distracting design. Titles are bold, and all further text on the cards use the “OpenDyslexic” text font proving Dyslexia friendly (7) so that visual capabilities do not block understanding or cause disadvantage.

Interaction is frequent throughout the game, and although players are encouraged to quickly recognise their desired codons, there is no reliance on speed or requirement for quick actions within gameplay. Furthermore, most of the information during game play is shared publicly on the table. This reduces cognitive load and makes the game more suitable for mixed ability groups.

Learning Context and Use in Teaching:

Codon Clash is well suited as an in-class activity, especially for re-enforcing previously mentioned ideas around genetic translation. It functions as a guided practice task where teachers encourage players to read codons and amino acids aloud, as well as prompt discussion after key moments such as a stop codon interrupting the game. The teacher should encourage players to rely on recall rather than using any genetic code reference sheets previously provided as classroom material.

The game can also be used as a revision activity, as multiple short rounds allow repetition of the same core ideas, strengthening memory through retrieval practice.

The game is inexpensive and does not require many resources or much space. Multiple copies can be distributed throughout classrooms, meaning players can be constantly engaged without uninteresting waiting periods between games.

Design Process:

A major challenge faced when designing the game, was trying to avoid a worksheet feeling. Early ideas required players to explain their reasoning and play choices which slowed play and excluded less confident speakers. This was solved by making answers short and binary, stating simply whether a codon matches, or does not.

It was also important that we solved the issue where multiple players could hold the same amino acid card, as it became aware to me when solo-playtesting the game that multiple players could try to claim a codon. This would either result in arguments or reliance on speed. None of which were element that we wanted to be brought into the game. We solved this issue by only creating a single copy of each amino acid card within each deck.

Future Development:

An advanced model of the game could remove codon lists from the amino acid cards, requiring full memorisation, and instead provide a reference sheet for look up after to ensure correct matching of amino acids and codons. Another option could be to introduce mutation cards into the deck, that alter players individual nucleotide sequences or allow players to change opponents played codons and edit them to suit their own cards.

A companion app could be made, pronouncing amino acid names, providing further information on structure and function and presenting the chemical structure of the molecules would be an amazing step, enhancing accessibility and learning opportunity without replacing the tabletop dynamic of the game.

Conclusion:

Codon Clash transforms the monotonous mapping of RNA codons to amino acids into an interactive competition. It embeds fundamental biological rules directly into its game mechanics, ensuring fun of the game and educational value are inseparable. Players repeatedly decode codons, recognise degeneracy, feel the disruptive effects of stop codons, all while racing to build their amino acid chains and discard their cards.

Knowledge is not lectured to the players but arrives naturally during gameplay. Success ensures correct understanding and application of the genetic code.

References:

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