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GeneX Learning Kit

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ABSTRACT

Gene expression to produce protein is divided into transcription and translation. Messenger RNA (mRNA) is transcribe from a sequence of the DNA strand that acts as a template in a process called transcription. The process in which the base sequence on the mRNA is used to synthesize amino acids sequence is called translation. GeneX Learning Kit is designed to provide hands on learning tools for students to interact and discuss in group guided by instructor. Student are able to simulate the process of gene expression by controlling the DNA sequence, mRNA strand, tRNA, ribosomes, and amino acid sequence. It can accommodate 5-6 students at maximum per group. The GeneX Learning Kit is light weight, and portable, suitable to accommodate learning process in classroom. It is equipped with game-based activity for better facilitative communicative engagement in learning protein synthesis. This kit is suitable to be used in a classroom and as laboratory practice during learning genetic expression. The interactive and competitive nature of playing the GeneX Learning Kit provides a fun and meaningful learning experience not confined to the traditional learning method. Therefore, learning and practicing the process of gene expression will become interesting and entertaining.

Keywords: Transcription; translation; protein synthesis; genetic expression; educational kit

1. INTRODUCTION

The deoxyribonucleic acid (DNA) contains genetic information which encodes specific trait by dictating the protein synthesized or, in some cases, ribonucleic acid (RNA) is functioning as RNAs instead. The process of gene expression into proteins is divided into transcription and translation. The process in which the DNA is used as a template in producing messenger RNA (mRNA) is call transcription which later is the mRNA is transported from the cytoplasm to the nucleus. The nucleic acid; DNA and RNA use different nucleotide bases which may causes obfuscation to sometimes happen. Adenine (A), Guanine (G), Cytosine (C), Thymine (T), and Uracil (U) are the five nitrogenous bases. DNA used A, T, C, and G whereas RNA used A, U, G, and C. These differences may cause confusion among students. The other process so called translation is to synthesize amino acids base on the nitrogenous base sequence of the mRNA. Translation on the other hand is to synthesize a sequence of amino acids based on the nitrogenous base sequence in mRNA. An amino acid is coded by three nitrogenous base sequence called codon. By using the mRNA codon table, one can translate the codon sequence of the mRNA to its respective amino acid.

Gene expression also involves numerous proteins, enzymes as well as other RNAs. The transcription is divided into three substages known as initiation, elongation and termination producing a pre-mRNA. The pre mRNA then undergoes modification in eukaryotic cell to making it a functional mRNA. Once transcription is completed, translation proceed which also divided into three stages known as initiation, elongation and termination.

Teaching and learning protein synthesis have always been an issue not only among students, but also among teachers [1]. Findings showed that inability to relate concept of protein synthesis and misconception are the main cause of teaching and learning difficulties among teachers and students respectively.

Therefore, in order to increase students' interest and understanding, a creative approach must be taken. A study was found that learning by games creates fun learning experience which help student further develop their curiosities and interest in a particular topic [2]. Narrowing down into learning protein synthesis, another study by Mensch and Rubba in 1991 used CPVC pipe, polypropylene rope etc as a hand on model to develop students' positive attitudes towards biology and deepens their knowledge [3]. Later, another study by Sphren in 1993 suggested a teaching method using Lego and later the idea is improvised by another study by Mark in 2002 [4][5]. In 1995, Rode proposed a simulation using students' themselves acting as elements needed during protein synthesis [6]. The simulation requires a minimum of 21 students at one time with a tedious material preparation needed.

In a recent study in 2018, learning protein synthesis through board games provides a symbolic representation of the process in which the students played the roles of the molecule and simulate its process [7]. This provides meaningful learning towards the students. Many approaches have been introduced by science instructors to improve learning efficiency on gene expression into protein [8]. Therefore, this kit is developed to help instructors in conducting efficient 21st century learning in the classroom.

2. INNOVATION DEVELOPMENT

The GeneX KIT can accommodate 5-6 person per group. It is suitable to be used in a classroom and as laboratory practice. It uses simulation of a cell undergoing protein synthesis step by step to enlighten students understanding and creating visualisation for easy memorizing.

GeneX Kit

Instructor's set is equipped with magnetic models that stick to whiteboard. Models include DNA strand, mRNA strand, RNA polymerase enzyme, complete labelled of ribosome, tRNA and amino acid molecules. Since GeneX Kit uses simulation approach, it consists of all elements needed in transcription and translation. It includes erasable board with printed figures, an mRNA strand, tRNA, amino acid and DNA sequence card.

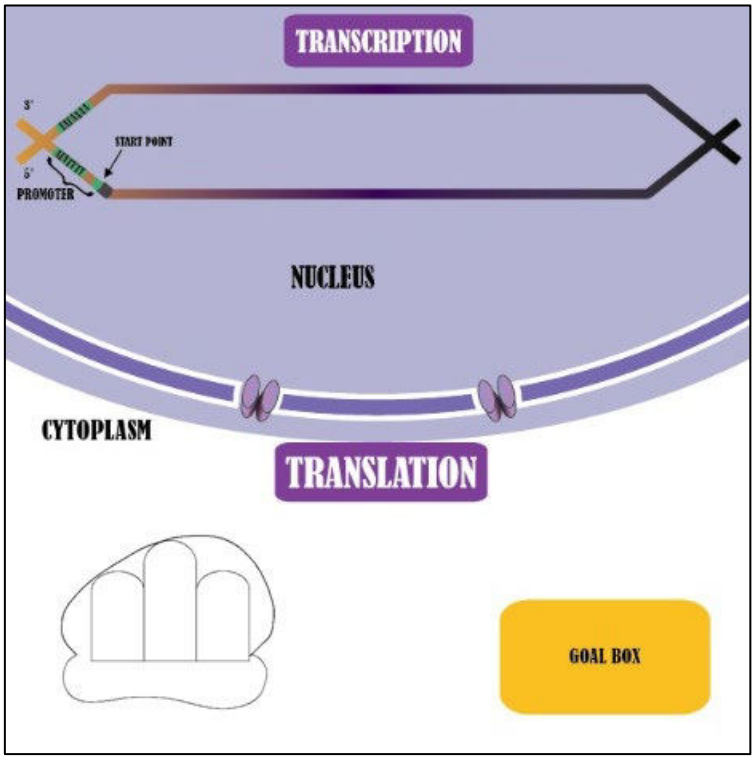

Figure 1: An erasable board illustrating a cell showing an unwinding DNA strand with 3'-5' direction labelled within nucleus. Structure of ribosome with three unlabelled sites outside of nucleus (cytoplasm) and a goal box; to be used for game-based exercise

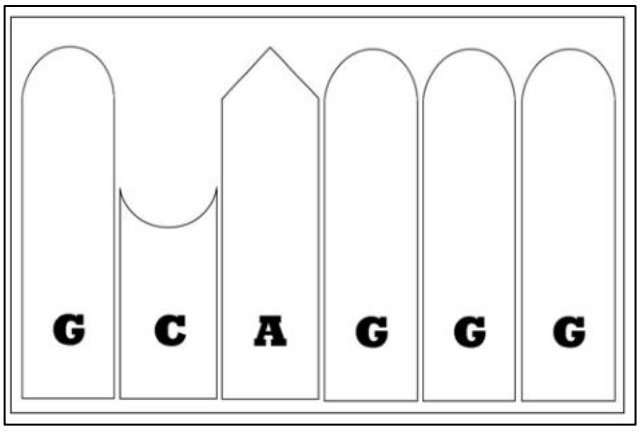

Figure 2: A total of 15 transparent DNA card with different base sequence. Each card represents 2 complementary codon which will contribute to two amino acid sequence

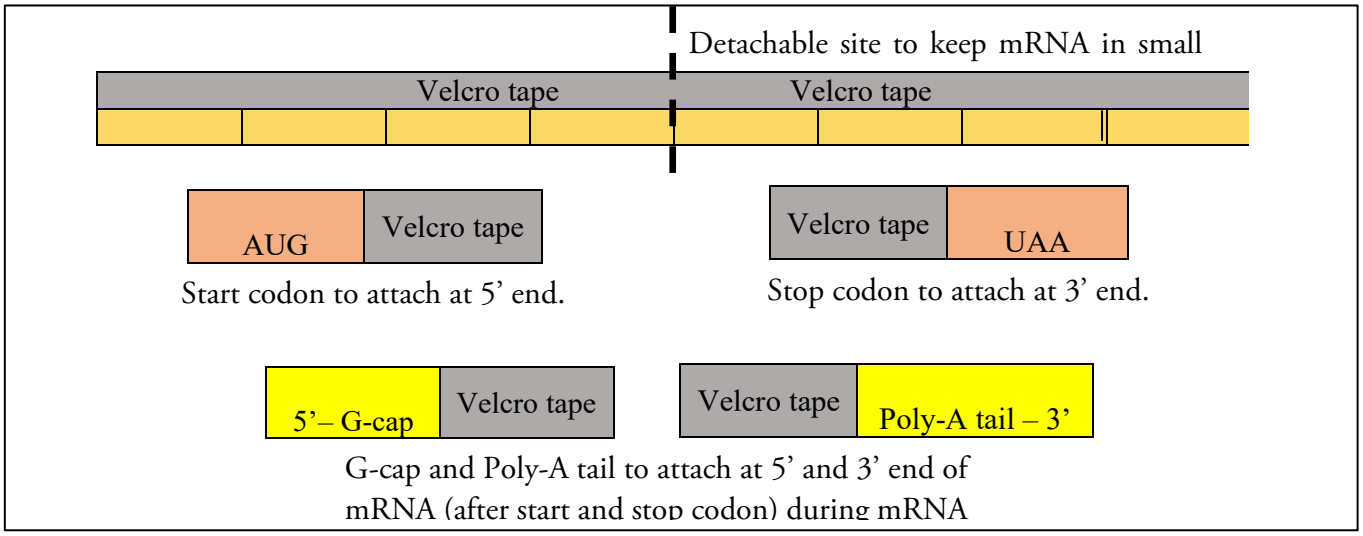

Figure 3: An mRNA strand with Velcro tape to attach to each other as well as to other transcription and translation elements. Erasable mRNA strand has 8 blank box for students to write RNA bases complementary to DNA sequence on DNA card

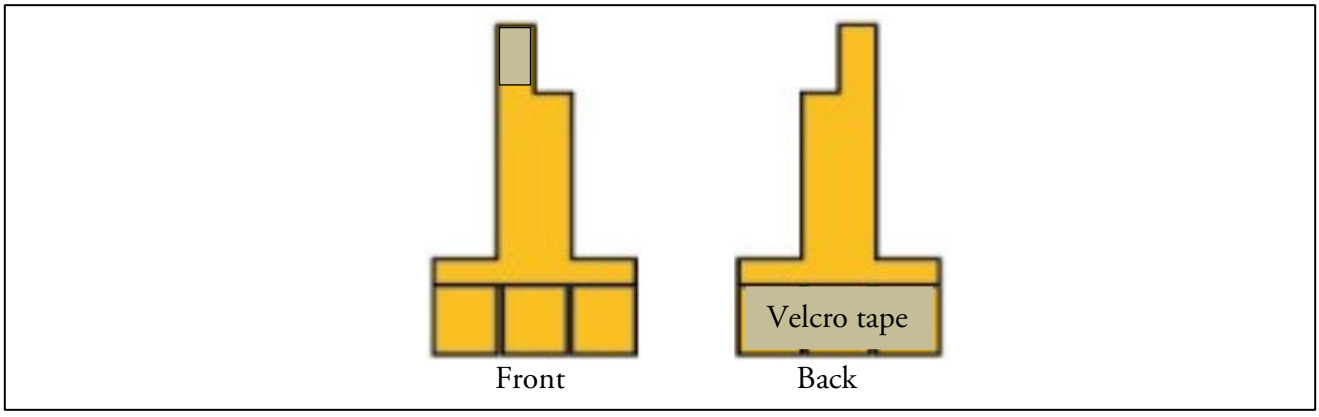

Figure 4: A total of 9 tRNA in a set of GeneX kit. Blank box in front to write three anticodons complementary to mRNA in 3'-5' direction. Velcro tape at the back is used to stick to mRNA

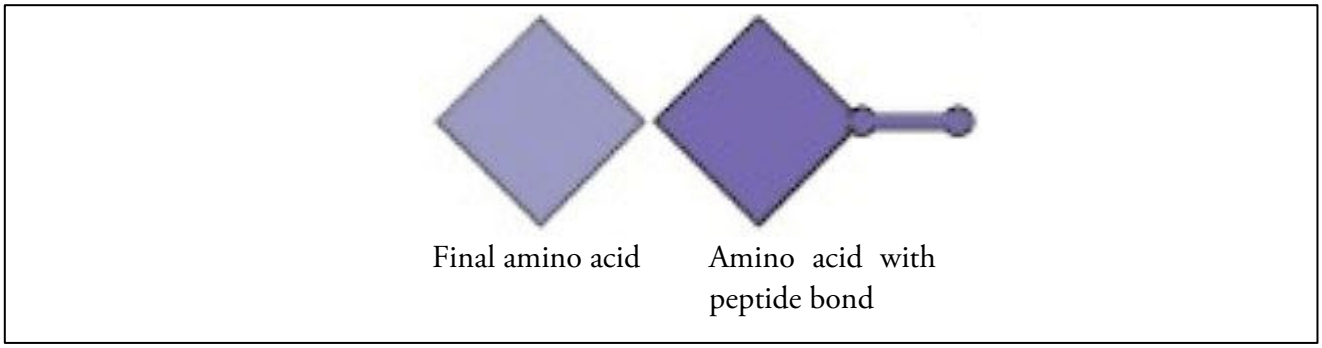

Figure 5: Two different amino acid with Velcro tape at the back to stick to tRNA and to other amino acid. All amino acids are erasable for students to write specific amino acid that match to codon based on codon mRNA table. 8 amino acid with peptide bond and one final amino acid included in a set of GeneX

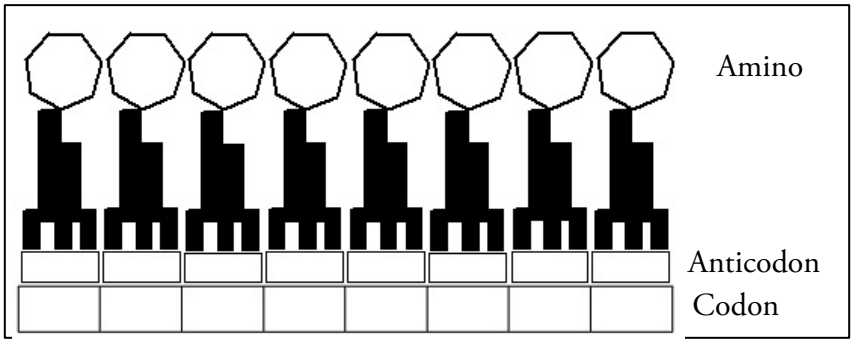

Figure 6: GeneX sheet for students to write down their own codon, anticodon and amino acid sequence as an exercise after simulation

Learning Outcome

Our aim for this simulation activity by students is to convey the followings learning outcome. After using this demo kit, students are expected to:

- Explain transcription process with its stages.
- Explain translation process with its stages.
- Match complementary base pair correctly.
- Translate codon into amino acid using mRNA codon table

Warm Up Session

Prior to beginning of the game, it is encouraged for instructors to divide students into groups randomly. Next, instructor will explain all transcription and translation process using traditional method such as chalk and board or by video animation. Other than that, Instructor may use GeneX Demo Kit to help instructor to explain clearly to students with students' engagement activity included. Students may have a bit of struggle and probably need to discuss in the group to connect protein synthesis process step by step. However, they will grab the key concepts as they begin the simulation using GeneX Kit.

Set Up

Shuffle all DNA card and place 4 cards on 3' – 5' strand which is the DNA template strand.

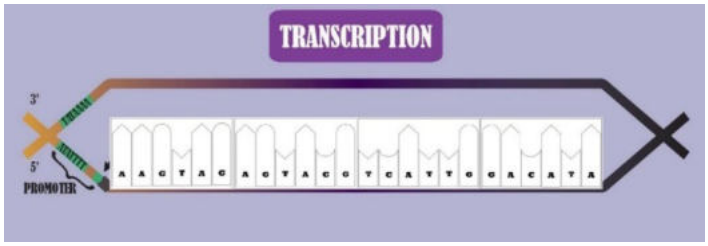

Figure 7: Board set up before simulation of protein synthesis begin

Simulation and Discussion

GeneX kit is designed to enhance students' group discussion using simulation and game-based approach. Students can try to run the all processes on their own using this kit as explained by instructor using **GeneX Demo Kit**. All transcription and translation process are very specific to each stage. Students may have to write down some elements on the erasable board. The simulation can be done few times for clearer understanding with different DNA sequence since DNA card is shuffled every time.

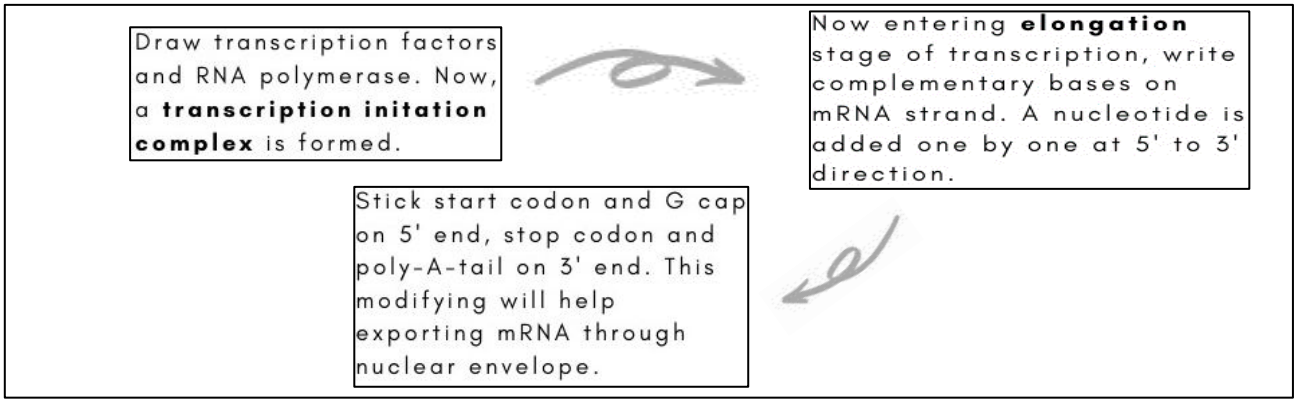

Figure 8: Simulation of transcription process using GeneX Kit

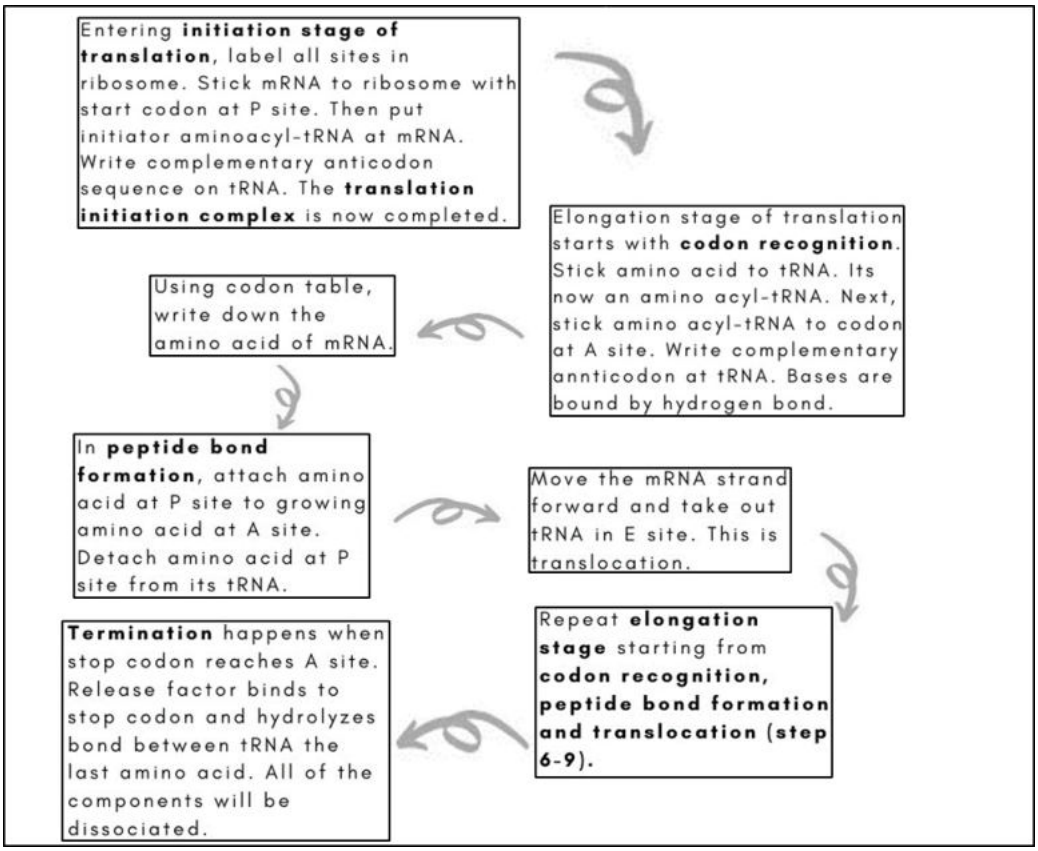

Figure 9: Simulation of translation process using GeneX Kit

Game-Based Exercise

For more excitement, GeneX sheets is included as a game-based exercise. Students' can play protein race. They can shuffle all 15 DNA cards again, transcript and translate the gene to protein sequence by writing the correct answer into their own GeneX sheet. The first player who can translate the right amino acid sequence will put the GeneX sheet in the goal box win the race.

3. COMMERCIAL POTENTIAL

GeneX kit provides fun, low-cost, and educative classroom activity. It includes simulation and game-based learning approach to fit in two different learning style of target students. A preliminary was conducted in a foundation centre to 15 students. The session has turned into a very interesting revision for them since protein synthesis was taught in the beginning of their semester. All the students give very supportive feedback and would suggest using GeneX kit as classroom activity and laboratory practice instead of traditional method. Undeniably, GeneX kit can provide effective learning strategy and suitable for all foundation centre and A-level institutions, schools with pre-U course, and matriculation college.

4. CONCLUSION

Challenges of the 21st century learning demands a creative approach to provide students with understanding as well as self-motivating to learn. GeneX KIT is developed to help instructors conducting the learning genetic expression process in fun and entertaining way to fit with the students' demand. Increasing the student's understanding on protein synthesis to boot. This kit has high potential to be a useful tool used in various schools, matriculation college as well as any foundation studies centre in Malaysia.

ACKNOWLEDGEMENT

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REFERENCES

[1] Gül, S, & Özay Köse, E. (2017). Prospective Teachers' Perceptions on Protein Synthesis: Recommended Solutions versus Learning Difficulty. *Erzincan Üniversitesi Eğitim Fakültesi Dergisi*. 20(1), 237-250.

[2] Cai, Y., Lu, B., Zheng, J., & Li, L. (2006), Immersive protein gaming for bio edutainment. *Simulation & Gaming,* 37(4), 466-475.

[3] Mensch, D. L., & Rubba, P. A. (1991). A study of large hands-on protein synthesis models in biology class. *School Science and Mathematics,* Vol 91, 4164–168.

[4] Sprehn, J. L. (1993). Protein building blocks: A concrete model for an Abstracts thought. *The Science Teacher*, 22–25.

[5] Mark, A. T., & Marcia, K. F. (2002). A Working Model of Protein Synthesis Using Lego™ Building Blocks. *The American Biology Teacher,* 64 (9), 673-678.

[6] Rode, G. A. (1995). Teaching protein synthesis using a simulation. *The American Biology Teacher*, 57, 150–52.

[7] De Cavalho, J.C.Q., Beltramını, L.M., & Bossolan, N.R.S. (2018). Usıng a board game to teach protein synthesis to high school students. *Journal of Biological Education*, Vol 53 (2), 205-216.

[8] Mohd, A. R., Nurul, A., Nur, R. H., & Norlizayati, R. (2017). Learning with Play at Work with ProS Game: Utilizing Game-Based Approach in Improving Communicative Skills during the process of Learning Protein Synthesis. *Asian Journal of University Education*, 13(2), 79-90.

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