Appendix C

The Overview of Activities in Each GIU

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1. Unit 1: DNA definition and significance (T=teacher, S=students)

1.1 Orientation Stage

T: uses ‘Tsunami’ transparency and situation for identify person’s identity by using DNA and ask questions of significant of DNA.

T: uses ‘Human finger in fermented meat’ transparency and situation for identify person’s identity by using DNA and ask questions of evidences and specimens.

S: set questions about ‘Tsunami’ and ‘Human finger in fermented meat’, which are related to DNA.

1.1 Focus Stage:

S: check their prior knowledge of chromosomes, DNA, cell division by using worksheet.

T: uses the students’ questions to link with ‘Miss Jingjai and Mr. Sandee’ in television drama and finds volunteer to talk about how to find Mr. Sandee’s father.

T: uses ‘DNA bands of father, mother, and son’ transparency and asks question for the same and different DNA bands of son and their parents.

S: (5-6 students in small groups) conclude ‘Who is millionaire’s son?’ activity sheet.

T: leads for whole class discussion.

S: (whole class) discuss to conclude;
-Each person has same DNA as father and mother for each half.
-DNA is genetic materials, which let living organisms contain their species from generation to generation.
-DNA checking technology has benefits to people in society.

S: (5-6 students in small groups) discuss the relationship of DNA, chromosome, nucleus, and cell.

T: uses students' questions (significance of DNA and DNA with identified person) links to cell division, which students had already learnt by using 'The relationship of DNA, chromosome, nucleus, and cell' transparency.

T: asks questions to raise students' thinking of cell division, components of chromosome, DNA with identified person from former activities.

T: uses the students' questions of position of DNA in body links to revise students' knowledge of cell with using 'Cell structure' transparency.

S: (5-6 students in small groups) discuss meaning of cell, cell components, and function of important components in cells.

1.3 Conclusion Stage:

S: (whole class) discuss to conclude position and terminology of DNA, and relationship of DNA and chromosome in living organisms.

2. Unit 2: DNA discovery

2.1 Orientation Stage:

T: refers to using DNA bands for finding millionaire's son links to how scientists' discover DNA and scientists' Nobel Prize experiment.

2.2 Focus Stage:

T: asks students' prior knowledge of grouping living organisms in each Kingdom, especially bacteria and cell type of bacteria.

T: uses 'Griffith's experiment of *Pneumococcus sp.* type R and S' transparency and asks questions.

S: (5-6 students in small groups) discuss about something which can change non pathogenic bacteria to be pathogenic bacteria in the experiment.

T: explains with uses 'Avery, McCloid, and McCarty's experiment with protease, RNase, and DNase' transparency and asks questions to raise students' thinking.

S: (5-6 students in small groups) discuss the conclusion of the latter experiment and whole class discussion.

T: leads whole class discussion by mixing both of the experiments and asks questions of the cause of living *Pneumococcus sp.* type S, the cause of dead rat in the first experiment, and the benefits of the latter experiment.

S: (whole class) discuss for the origin of scientific knowledge, which can change when have superior explanation or evidences.

2.3 Conclusion Stage:

S: (whole class) discuss for discovering DNA, that scientific experiment confirm it is genetic materials because it can transfer from one specie to another specie.

3. Unit 3: DNA chemical components and structure

3.1 Orientation Stage:

T: refers to DNA discovery and links to study about chemical components of DNA.

S: do work sheet for finding their prior knowledge of chemical components of DNA.

3.2 Focus Stage:

S: do ‘Looking for chemical components of DNA’ activity sheet by using plastic model to find components of nucleotide.

T: shows ‘Components of nucleotide’ transparency.

S: tell the name of each plastic piece, which represents components of nucleotide on DNA.

S: (5-6 students in small groups, and then in whole class) do activity of composing polynucleotides and DNA.

S: (whole class) discuss for finding answers in worksheet.

3.3 Conclusion Stage:

T: uses questions for whole class discussion of; a variety of bases in DNA, chemical components of DNA, and DNA structure.

S: (whole class) discuss for conclude;

-Ordering of bases in DNA are varies.

-Each DNA molecule is composed of 2 polynucleotides.

-Each poly nucleotide is composed of nucleotides.

-Each nucleotide is composed of base, sugar, and phosphate group.

4. Unit 4: Invention of DNA model

4.1 Orientation Stage:

T: shows DNA plastic model which students invented in Unit 3, and DNA paper model. Then, asks question 'What are they?'

S: answer both of them are DNA model.

T: asks for the similarity of each model.

S: answers;

-Ordering of bases in DNA are varies.

-Each DNA molecule is composed of 2 polynucleotides.

-Each poly nucleotide is composed of nucleotides.

-Each nucleotide is composed of base, sugar, and phosphate group.

T: asks questions for revising students' knowledge such as;

-How many base types of DNA?

-What are they?

-How do they match in pair?

4.2 Focus Stage:

S: (5-6 students in small groups) consider DNA paper model and plastic model for creating and inventing their own DNA models by considering about the main chemical components and structure of DNA. Each group has to find some equipment by themselves and has plan for finishing it in a week.

S: (whole class) set criterions for marking their DNA model.

T: writes the criterions on transparency.

T: revises students' performance for cooperating learning, such as responsibility of each member.

S: Each group plans invention of DNA model and presents the plan to teacher.

T: gives opinion in each plan of each group.

4.3 Conclusion Stage:

S: (whole class) discuss the chemical components and structure of DNA and revise the criterion of marking their DNA model.

5. Unit 5: Presentation of DNA model

5.1 Orientation Stage:

T: decorates classroom by DNA paper model

T: reminds students for timing of presentation (15 minutes each with 5 minutes discussion) and for giving some points to each group.

5.2 Focus Stage:

S: (5-6 students in small groups) present their DNA model in front of the class and send the conclusion of members' responsibilities and budgets to teacher.

S: estimate each group and give some points by using the criterion which they set on Unit 4.

T: gives a toffee to each student.

S: (each student) gives a toffee to group which has the highest point in his or her opinion.

T: gives a prize to the group, which has the highest vote.

5.3 Conclusion Stage:

S: (whole class) discuss the chemical components and structure of DNA by considering their own DNA model.

S: concludes their learning from inventing DNA model.

6. Unit 6: Genome

6.1 Orientation Stage:

T: asks question about bases ordering in students' DNA model.

T: turns on music from 'Genomic Music' album and explains that the music comes from bases ordering of some part of *Labrador retriever* DNA and coded with music notes.

6.2 Focus Stage:

S: answer the different kinds of living organisms will have different tempo.

T: turns on music which decoded from shrimp and asks students for the different.

S: answer the different comes from different bases ordering of each living organism.

T: asks question 'if the arranger arrange all bases ordering of DNA in dog and shrimp, do you think the length of each song will be the same or different and why do you think like that?'

S: answer 'both songs have different length, because bases ordering of each living organisms have different length'.

T: uses 'The cover of genomic music album' transparency and asks question 'what do you see in the cover?'.

S: answer;
-Genomic music
-Songs of life
-A, T, C, G

T: asks 'what is the relationship of your answers?'

S: (5-6 students in small groups) discuss for meaning and the significant of genome.

6.3 Conclusion Stage:

S: (whole class) discuss for conclude that;

-Genome is the bases ordering of entries DNA in each living organisms.

-The significant of genome has contribution to understand mechanics of each living organisms and can use the knowledge of the bases ordering in developing related science and technology.

7. Unit 7: DNA properties (Part 1: DNA replication)

7.1 Orientation Stage:

S: write their prior knowledge of DNA by putting texts about chemical components of DNA into DNA structure chart.

T: random students to answer.

S: (whole class) discuss for the answers.

7.2 Focus Stage:

T: revise students' prior knowledge and links to DNA replication by using following questions;

-Why scientists call DNA as genetic materials?

-How is the significance of DNA with living organisms?

-Which stage of cell that living organisms transfer DNA to the next generation?

-How is about the quantity of your parents' DNA, when living organisms transfer DNA from parents to your generation?

-How is the way DNA were transfer from parents to you, but they still have the same quantity of DNA?

S: (5-6 students in small groups) uses DNA plastic model with activity sheet for doing model of DNA replication.

T: uses questions to raise students' thinking DNA replication and explains about 5'Phosphate and 3'OH.

S: (5-6 students in small groups) answer question.

T: uses 'DNA replication' transparencies for asking questions.

S: (whole class) discuss of DNA replication.

S: (5-6 students in small groups) work with activity cards for ordering of DNA replication.

S: (whole class) discuss of ordering of DNA replication.

7.3 Conclusion Stage:

S: (whole class) conclude;

-DNA replication is a synthesis of new DNA by using an old DNA as a template.

-When chemical bonds of Adenine (A) and Thymine (T), and Guanine (G) and Cytosine (C) were gone, polynucleotide will separate. Then, free nucleotides in cell will match with nucleotides of the old polynucleotide by matching between A and T, and G and C. Phosphate group of free nucleotide catch with deoxyribose sugar of next nucleotide.

8. Unit 8: DNA properties (Part 2: DNA Transcription)

8.1 Orientation Stage:

T: checks students' prior knowledge of DNA and RNA.
T: random students to answer.
S: (whole class) discuss for the answers.

8.2 Focus Stage:

T: shows DNA plastic model which students studied about DNA replication in Unit 7.
T: raises students' curiosity that how can we call the process which consider only a polypeptide of DNA, and change Thymine to Uracil.
S: (5-6 students in small groups) study 'DNA transcription' worksheet.
T: random students to answer.
S: (whole class) discuss for the answers.
S: read 'DNA: code of life' and answer questions about DNA transcription, such as other names of DNA transcription, template of DNA transcription, DNA transcription process, DNA transcription direction, three types of RNA, codon, and anticodon.

8.3 Conclusion Stage:

S: (whole class) conclude;
- DNA transcription or RNA synthesis has DNA as template. RNA molecule starts from 5' to 3'.
-RNA has three types: mRNA (messenger RNA), rRNA (ribosomal RNA), and tRNA (transfer RNA).
-Codon is three bases on mRNA.
-Anticodon is three bases on tRNA, which can match with codon.

9. Unit 9: DNA properties (Part 3: Translation)

9.1 Orientation Stage:

T: asks questions of codon and anticodon and raise students' curiosity that students' will know about relationship of DNA transcription to traits of living organisms.

9.2 Focus Stage:

S: see videotape of 'Translation and protein synthesis' and answer in 'Translation and protein synthesis' worksheet.
T: stops videotape and asks questions time by time.
S: (5-6 students in small groups) discuss answers.
S: (whole class) discuss.
T: uses 'V.M. Ingram's experiment' and 'Haemoglobins of people with and without sickle cell anemia' transparencies for whole class discussion.
S: (5-6 students in small groups) discuss and find answers in 'Proteins with genetic traits' worksheet.
S: (whole class) discuss.
S: answers in 'Process of protein synthesis' worksheet.
S: (whole class) discuss the answers.

9.3 Conclusion Stage:

S: (whole class) conclude of; process of protein synthesis, function of mRNA; function of tRNA, and significance of codon.

10. Unit 10: Mutation

10.1 Orientation Stage:

T: asks questions of DNA, bases, and amino acid.
S: volunteer to read ‘Strange Tree’ story.
T: asks questions of the causes of mutation and write students’ answers on the board.

10.2 Focus Stage:

S: (5-6 students in small groups) discuss and find out the answers in ‘Decoding life codes’ worksheet.
S: (whole class) discuss the answers and show their answer on ‘Genetic codes table’.
T: turns on VCD ‘A monkey face child’.
S: (whole class) discuss the cause of monkey face of the child.
S: volunteer to read ‘Grilled pork’ story.
S: (5-6 students in small groups) discuss to find answers in ‘Mutation’ worksheet.
S: (whole class) discuss the answers.
T: asks questions about the causes of mutation; how to protect yourself from mutation; and the effects of mis-ordering of bases.

10.3 Conclusion Stage:

S: (whole class) discuss for conclusion;
-Mutation is abnormal of genetic traits, which include base deletion, base insertion, base change, or base inversion, etc.
-Mutation can be caused by nature or carcinogens, such as radiation, chemical agents, some food.
-Advantages of mutation are having stronger or good property living organisms.

-Disadvantages of mutation are having weak or strange living organisms, which can be the cause of social problems.

11. Unit 11: Genetic engineering

11.1 Orientation Stage:

S: volunteers talk about Geneic Modified Organisms (GMOs), which heard from a variety of media.

11.2 Focus Stage:

S: volunteer reads ‘Papaya GMOs’.
S: set questions about GMOs.
T: writes students’ questions on the board.
S: (5-6 students in small groups) two groups read ‘Plant GMOs’ story and other two groups read ‘Genetic engineering’ story. A student who read ‘Plant GMOs’ story match with a student who read ‘Genetic engineering’ story and explain their understanding to each other.
S: Each pair answer ‘GMOs and genetic engineering’ worksheet.
S: (whole class) discuss the answers.
S: do activity sheet by using actor cards and situation cards for playing their roles to make decision about genetic engineering situation in daily life.
T: leads whole class discussion of genetic engineering and social values.

11.3 Conclusion Stage:

S: (whole class) conclude;
-Genetic engineering is the technique for manipulate DNA molecules *in vitro* by cutting target DNA by using restriction enzyme. Then, ligate with vector by DNA ligase, and introduce the recombinant DNA in to host cell for amplification. The recombinant DNA, which transformed into cell, has to replicate itself.
-Genetic engineering can be applied to producing hormones, vaccines, parts of DNA, modify microorganisms or plants or animals.

12. Unit 12: Mini Molecular Genetics Fair

12.1 Orientation Stage:

T: shows classroom diagram, which shows position of each group, on the board and set time for preparing places and presentation.

12.2 Focus Stage:

S: (5-6 students in each group) prepare their presentations.
T: looks around and helps when students' ask.
S: (5-6 students in each group) present their own topics.
T: attends in each group and asks questions to raise their thinking.

12.3 Conclusion Stage:

T: revises all genetic concepts in 11 Units and students' presentation.
S: (each student) answers in 'Concept map of molecular genetics'
S: (whole class) discuss the answers.