THE CHINESE UNIVERSITY OF HONG KONG

Courseware Development Grant (2016-17)

Final Report

PART I

Project title: To generate virtual reality molecules for Molecular Biology
Principal supervisor: P.C. Shaw
Co-supervisor(s)
Department / Unit: School of Life Sciences
Project duration: From April 2017 to April 2018
Date report submitted: 30 April, 2018

1. Project objectives

Is the project on track to meet its objectives?
Have the objectives been changed as a result of the experience of working on your CDG project?

This project is to generate a collection of virtual molecules for Molecular Biology course aiming to help students understand and remember the three-dimensional structures and the molecular interactions between them for carrying out the function.

While the traditional classroom uses diagrams and models to represent the biomolecules, student engagement in learning molecular biology can be enhanced by application of virtual-reality technologies such that students can manipulate molecules, see the molecular structures in three-dimensional space interactively. This aims to increase their motivation and engagement of learning.

Virtual molecules that we originally planned to generate are about 30 including: Different forms of DNA, transfer RNA, mRNA, four types of nucleotides, four bases, ribosomes, ribosome complex, histone-DNA, DNA polymerase, DNA helicase, RNA polymerase etc.

Because of the complexity of some of the biomolecules and the budget constraint, some of the molecules are combined into one model in order to better illustrate the structure as a whole from user point of view and it can also reduce the development time. For

example, 30S ribosome, 50S ribosome, 70S ribosome and mRNA-ribosome complex can be combined in one virtual molecule in one complex model. The end date of the project has been extended for three months, from 30 Jan 2018 to 30 April 2018.

Finally, 22 virtual biomolecules (Table A) are generated. They are divided into 7 categories as below:

A. Purine and pyrimidine base
B. Nucleotide
C. Base pairing
D. Different form of DNA
E. Transfer RNA
F. Ribosome
G. Other important molecules for molecular biology

Table A: List of virtual biomolecules

Category	Virtual Biomolecule
1. Purine and pyrimidine base	Adenine (A) Guanine (G) Cytosine (C) Thymine (T) Uracil (U)
2. Nucleotide	ATP CTP GTP TTP UTP
3. Base pairing	A-T (Adenine-Thymine) C-G (Cytosine-Guanine)
4. Different form of DNA	A-form DNA B-form DNA Z-form DNA
5. Transfer RNA	Transfer RNA
6. Ribosome	Ribosome
7. Important molecules for molecular biology	Histone-DNA DNA polymerase DNA helicase RNA polymerase DNA ligase

The molecules are labeled for important atoms and dimensions on bond length and atom. There is a brief description for each molecule, followed by revision MC

questions for the biomolecules. A mobile app (named VR Biomolecules) is developed which allows students get access to the molecules through Mobile device, in both Android or iOS, and VR head-mounted display sets.

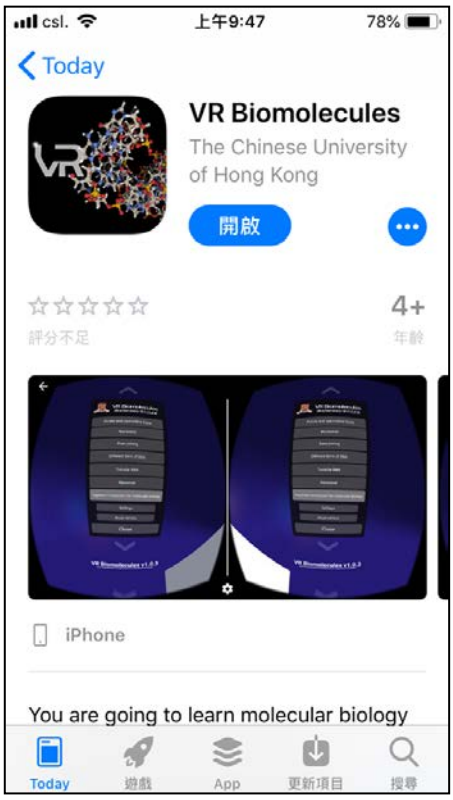
The courseware materials can be used for: (1) flipped classroom, (2) appreciate the 3-dimensional structures and key features of molecules, (3) for courses in other teaching programmes that cover the same topic.

2. Process, outcomes or deliverables

Please specify the number of different types of deliverables produced, and the course(s) (with course codes and titles) that have used the deliverables in Part IV, and provide more detailed descriptions here.
Has the nature of the deliverables been changed?
Have you adjusted your timeline?
Overall, was the project completed satisfactorily?

A mobile App, named VR Biomolecules (Figure 1) has been developed. It can be used in both iOS and Android platform. User can easily download the app from App Store or Google Play. The app allows users to manipulate biomolecules in 3-D using virtual reality headset.

Figure 1: Mobile app in App Store



The 22 virtual biomolecules (figure 2) will be used in Molecular Biology course (BCHE3050). This course discusses basic areas of molecular biology. Topics include:

DNA and genome, DNA replication, transcription, translation, gene regulation, DNA mutation, recombination and repair.

For each biomolecule, brief description (Figure 3) and 5 to 10 revision questions (MCQs) (Figure 4) are generated and the materials are posted to Blackboard for related courses. Students can revise what they have learnt by doing the revision questions provided.

Figure 2: Screen capture of VR Biomolecules from Mobile device

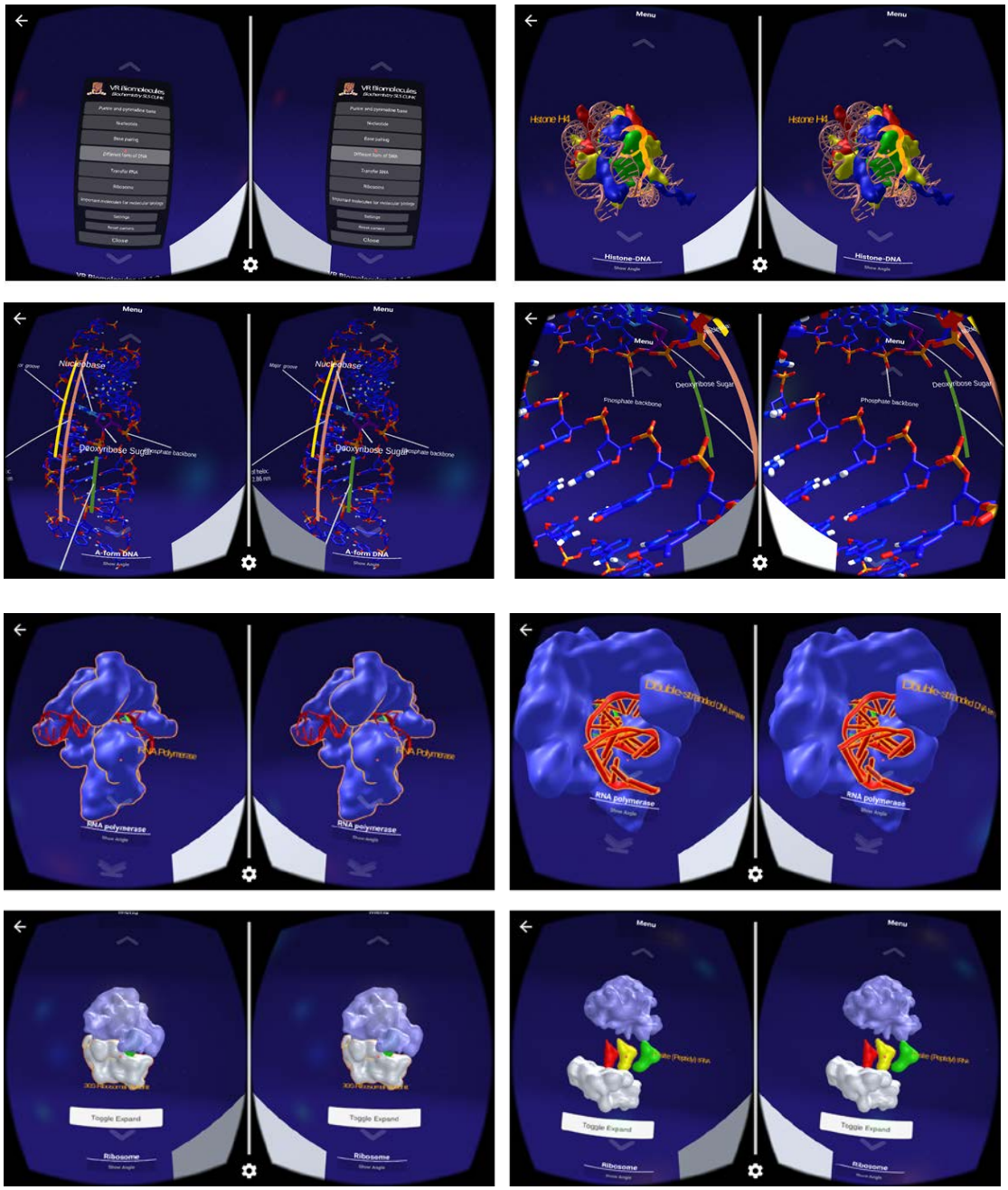


Figure 3: Brief description of a VR Biomolecule.

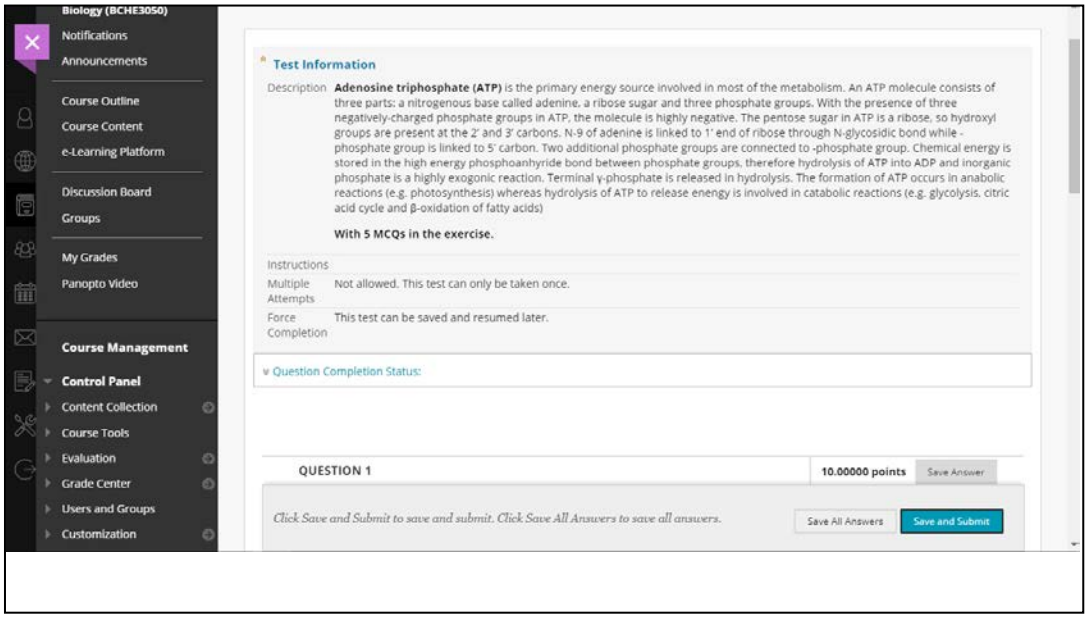
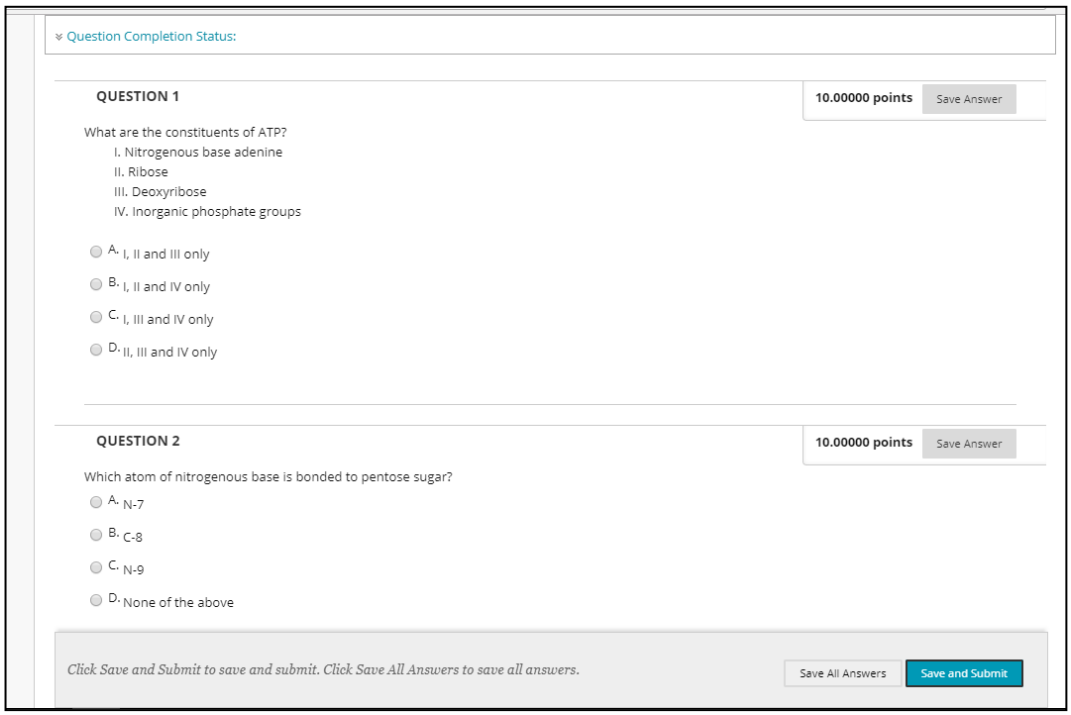


Figure 4: Examples of questions (MCQs) of VR Biomolecule.



In the project process timeline, we have 3 stages:

1. <u>Content preparation stage</u>

In this stage, Virtual molecules requirement specification were prepared by teacher. For each biomolecule, pdb files (file format of molecular graphics software eg. software Chimera and Visual Molecular Dynamics VMD) and powerpoint files for structure labelling were generated for development.

2. Design and development stage

In this stage, development team converted pdb files to be readable by another 3D Software (3D Studio Max) for further VR development in game development platform (e.g Unity). Afterward, apk file (Andriod package file) was generated for test run.

3. Testing, fine-tuning and deliverable deployment stage

In this stage, our assistant tested and confirmed the deliverables (apk files) according to the requirement specification (pdb files and powerpoint files), and provided feedback for fine-tuning. Updated version of apk file was released after fine-tuning. Final version of application file was generated to meet mobile app requirement for launching in App Store and Google Play for mobile device download.

Project process timeline is summarized in table B as below:

Table B: Project timeline, Process and Deliverables

Timeline	Process	Deliverables
April 2017 - Sep 2017	• Content preparation: Requirement specifications (in Pdb files and powerpoint files) of each biomolecule are prepared. • Design and development of VR Biomolecules (batch 1) The batch included 8 VR biomolecules as below: 1. Adenine (A) 2. Guanine (G) 3. Cytosine (C) 4. Thymine (T) 5. ATP 6. CTP 7. GTP 8. TTP	
9 Sep- 2017	Program file generated for testing Trial version of VR Biomolecules (batch 1)	• apk file (Android package file)

Aug 2017 - Nov 2017	• Content preparation: Requirement specifications (in Pdb files and powerpoint files) of each biomolecule are prepared. • Design and development of VR Biomolecules (batch 2) Batch 2 include 8 VR biomolecules as below: 1. Uracil (U) 2. UTP 3. A-T (Adenine-Thymine) 4. C-G (Cytosine-Guanine) 5. A-form DNA 6. B-form DNA 7. Z-form DNA 8. Transfer RNA	
3- Oct- 2017	Trial version generated for testing (batch 1 &2) (except A-form DNA, B-form DNA and Z-form DNA)	• Apk file (Android package file)
Nov-2017	Trouble shooting and fine-tuning (batch 1& 2)	
6 Dec 2018	Trial version generated for testing	• Apk file (Android package file)
Dec 2017- Jan 2018	Trouble shooting and fine-tuning of VR Biomolecules (batch 1& 2)	
Oct 2017- Jan 2018	Student helper was recruited to generate descriptions and revision questions for 22 VR Biomolecules. They are posted to blackboard of	• VR Biomolecules description and MCQs (22 sets)

	Molceular Biology course.	
25-Jan-2018	Mobile app (named VR Biomolecules) of iOS and Android release. 13 VR biomolecules of 4 categories are available. They are <u>Purine and pyrimidine base</u> Adenine (A) Guanine (G) Cytosine (C) Thymine (T) Uracil (U) <u>Nucleotide</u> ATP CTP GTP TTP UTP <u>Base pairing</u> A-T (Adenine-Thymine) C-G (Cytosine-Guanine) <u>Transfer RNA</u> Transfer RNA	• Mobile app of iOS and Android
Feb 2018- Mar 2018	• Formation of focus group by recruitment • Trial run on mobile app VR Biomolecules • Questionnaires preparation and its distribution • Students feedback collected for further improvement on VR Biomolecules.	• Evaluation result

Jan 2018 –April 2018	• Requirement specifications (in Pdb files and powerpoint files) of each biomolecule are fine-tuned. • Design and development of VR Biomolecules (batch 3) Batch 3 include 6 VR biomolecules as below: 1. Ribosome 2. Histone-DNA 3. DNA polymerase 4. DNA helicase 5. RNA polymerase 6. DNA ligase	
17-April 2018	Trial version generated for testing before final release. Fine-tuning is on-going.	• Apk file (Android package file)
30-April 2018	Final version generated for testing before final release.	• Apk file (Android package file)

3. Evaluation Plan

Have you altered your evaluation plans?
What monitoring data did you collect?
Does your evaluation indicate that you have achieved your objectives?

Feedback from Focus Group

From Feb to Mar 2018, focus group was formed by recruitment. They were invited to test run the courseware and feedback from them and suggestions for improvement were

solicited through questionnaires. A total of 21 students participated in the focus group. They are year 2 to year 4 students studying Molecular Biology (BCHE3050 and BCHE4010) and Molecular Biology and Recombinant DNA Laboratory (BCHE3650).

Feedback are summarized as below:

A. Regarding the electronic device that they use for accessing the app

Table C: Electronic device that they use for accessing the app

	a. Android OS	b. iphone OS	c. Others	Total
Total count:	**10**	**11**	**0**	**21**
Total %:	**48%**	**52%**	**0%**	**100%**

From the result (Table C), about half of the students (52%) use iphone OS. 48% of them are use Android OS. Therefore, it is important to develop the courseware that are accessible by both iOS and Android mobile device.

B. Content of VR biomolecules:

Table D: Elements according to Content of VR biomolecules

Rate the following elements according to Content of VR biomolecules: (In Percentage)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total
a. VR biomolecules on apps are clearly labeled and help me understand and memorize the three-dimensional structures.	0%	10%	10%	67%	14%	100%
b. The brief description of each biomolecules is clear and precise that help me to understand the structures and interactions between them that enable functions.	0%	5%	29%	62%	5%	100%
c. The biomolecules included in the VR apps are relevant to the topic.	0%	0%	0%	29%	71%	100%
d. The biomolecules are well categorized and easy to follow.	0%	5%	5%	43%	48%	100%
e. Revision questions (on blackboard system) help me to evaluate what I have learnt.	0%	19%	19%	57%	5%	100%

From the result (Table D), most of the students agree (67% agree, 14% strongly agree) that VR biomolecules on app are clearly labeled and help them understand and remember the three-dimensional structures, while 10% of them are neutral and 10% of them disagree with it. Moreover, most of students agree (62% agree and 5% strongly agree) that the brief description of each biomolecules is clear and precise that help them to understand the structures and interactions between them, while 29% of them are neutral and 5% of them disagree with it. Also, all of them agree (71% strongly agree, 29% agree) that the biomolecules included in the VR app are relevant to the topic. Nevertheless, most of them agree (43% agree, 48% strongly agree) that the biomolecules are well categorized and easy to follow. 5% of them are neutral and

5% of them disagree with it. Moreover, most of them agree (57% agree, 5% strongly agree) that revision questions (on blackboard system) help them to evaluate what they have learnt. 19% of them are neutral and 19% disagree with it.

C. Using VR Biomolecules as learning tools of Flipped classroom

Table E: Agreement of using VR Biomolecules as learning tools of Flipped classroom

Rate your agreement with the following statements: (In Percentage)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Nil	Total
a. VR biomolecules increase my motivation and engagement of learning in my course study.	0%	0%	24%	52%	24%	0%	100%
b. VR biomolecules provide me a fast and flexible way to understand biomolecules.	0%	5%	10%	67%	19%	0%	100%
c. VR biomolecules are suitable for studying at home as pre-class preparation.	0%	0%	38%	33%	24%	5%	100%
d. VR biomolecules are suitable to become part of in-class activity.	0%	14%	14%	48%	24%	0%	100%
e. VR technology is suitable for e-learning modules .	0%	5%	5%	67%	24%	0%	100%
f. The effectiveness of learning biomolecules is enhanced with VR technology.	0%	0%	29%	52%	19%	0%	100%

From the result (Table E), most of the students agree (52% agree, 24% strongly agree) that VR biomolecules increase their motivation and engagement of learning in course study. 24% of them are neutral. Moreover, most of them (67% agree, 19% strongly agree) agree that VR biomolecules provide them a fast and flexible way to understand biomolecules. 10% of them are neutral and 5% of them disagree with it. Also, they think that (33% agree, 24% strongly agree) VR biomolecules are suitable for studying at home as pre-class preparation. 38% of them are neutral. Majority think that (48% agree and 24% strongly agree) VR biomolecules are suitable to become part of in-class activity. 14% of them are neutral and 14% of them disagree with it. Majority (67% agree, 24% strongly agree) think that VR technology is suitable for e-learning modules. 5% of them are neutral and 5% of them are disagree with it. Most of them (52% agree, 19% strongly agree) agree that the effectiveness of learning biomolecules is enhanced with VR technology. 29% of them are neutral.

D. <u>The difficulties they encountered when using the VR biomolecules</u>

Some of the feedback are highlighted as below:

- For VR biomolecules, we cannot zoom out and I had to re-access the biomolecule every time.
- I zoom in a particular part of the biomolecule. Also, the lens for the VR is quite

blurry, I can't look at the biomolecules for more than 5 minutes at a time.

- The VR program can only magnify but not shrink the molecules. Also, the molecules are too high and it's dizzy to look up.
- At the very beginning, I do not know how to control the VR
- Sometimes, the direction of the camera is difficult to handle. Also the speed of the autorotate is still hurry, it makes me can't read the caption completely. The grey box which shown the atom is difficult to see through the vr biomolecule.
- Not knowing how to zoom in or out, shifting left and right, the molecule continue spin when pointing to a position to read the labels
- The scope of viewing angle should be enhanced, and the pop-up labelling should be made more to the center. They do not show the bonding (double/single) between the atoms.
- Sometimes it is hard to look at the VR biomolecules as the zoom in or out button does not work properly. The image may not be clear enough in a certain extent.
- The images on the sides of the screen are blurred and may be difficult to read. (especially the grey info box in the left-bottom corner)
- The rotation of the molecule is slow that I have to wait to find the angle I want
- The side notes were little bit blurry.
- need to turn my head around many times, is a bit tired for using VR to revision.
- It is difficult to manually spin the molecule, as you cannot grab the molecule.
- The loading time for tRNA molecule is also quite slow. Perhaps the file is a bit too large.
- adjust angle, unlike 3D model on the website or apps, VR molecules cannot be rotated by ourselves. Only lateral auto-rotated is allowed

E. <u>Suggestions to improve the VR biomolecules:</u>

Some of the feedback are highlighted as below:

- It might be better that we control the turning of the molecules instead of having it automatically rotating because sometimes we may want to look closely on a specific structure
- The pictures/animations can be clearer, it is not clearly shown and blurred, the eyes are quite tired after using the VR biomolecules.
- It would be better if the user could rotate the biomolecules manually.
- The description of VR molecules can put in the middle and of sharp colour for easier reading.
- Can add some video about the basic information of the biomolecules
- Can create the normal version for phone but not in VR for student who do not

want/cannot to use VR

- The arrow seems to be blurred
- More details can be show. The information of the revision question is better to make it more clear (e.g. point form) and on the screen
- I hope there is more and more bio molecules to came out as it is an effective tool to understand the structure of the protein and the DNA. And I hope I can watch the major grooves and the minor groove of the dna. Last but not least, the background music is quite weird
- The VR is a great tool for visualization of the molecules and binding in a 3 dimension manner and the app is very user-friendly. I believe it would be great for students to use it at home. However, I believe it is better not to use it in class as it may be quite consuming.
- Some instructions could be shown to use the app, the arrows on the platform for shifting up and down could be closer to the centre of vision. The molecules could be set to stop spinning when pointing to some specific positions of the molecules for the convenience of reading label.
- Double bonds of the molecules could be shown. For the questions on the Blackboard, the answers of Q1 and Q4 seem to be a bit strange.
- More flexible controls, more details in each molecule. More functions e.g. showing how the four bases form nucleotides
- More labeling is required for example, the molecules should show the position of double bonds
- Double bonds can be indicated with double lines (or with thicker lines), so that users can easily distinguish between them and other single bonds."
- Make the molecule a bit bigger
- Show the different types of bonds (hydrogen, ionic, etc) with different colors and some labelling.
- indication of the bond could be a bit clear. Can really classified the single or double bond

F. <u>Courses of which these VR materials may be suitable as teaching material:</u>

Feedback suggested that,

- courses involving study of molecular structure, like BCHE3050 and BCHE3070. And also courses about anatomy or physiology aspects, the VR material may show the structures and interrelationships between different body parts.
- BCHE2030: to study the amino acids structures.
- Method in Biochemistry. Especially in the second part (x-ray crystallography). The

three D models are too difficult to understand even if we have animations. I believe VR can help us to better understand the content.

- BCHE3050 would definitely be great if VR materials are supplied to have a better concept and understanding of the various biomolecules we are learning now as the binding sites or several molecules are complex. VR material can give a clearer view of it.
- Metabolic pathway, function of enzymes or proteins their active sites and interactions.
- Other courses suggested like BIOL2120, LSCI1002, BCHE3650, CHEM1280, BCHE2000.

G. Suggestion for topics for VR development:

Topics suggested are summarized as below:

- Protein structures, organization and structure of cell, human biology.
- Structure of amino acids.
- "VR field trip" during the lesson.
- Visualization of some life processes such as the DNA replication process
- Amino acid, molecules that have been taught in all life science course
- The display of some cell types may be a possible option.
- VR would be a great tool to study the structure of viruses as well.
- Histone modification, Prion, Virus, drug molecules.
- Observing virus and bacteria interaction with the cells, for example cell-signaling transduction pathway. Also, VR can be used to examine the detail body structures, like nervous system and blood circulating system.
- Other biomolecules like proteins/amino acids and carbohydrates can also be included.
- Some animations of the processes like DNA transcription and regulation
- Cell biology, gases cycling in the environment, Organic chemistry
- Other organic molecules (sugars, proteins, lipids), or simulations of the important biological process (such as DNA replication)
- Etc.

In conclusion, students gave VR biomolecules an encouraging feedback. Errors found and difficulties encountered were reviewed and some refinement action has been taken before final release. e.g. Sharpening the color of VR biomolecules, strengthening the control of zoom-in and zoom out, clearer user instruction for how to turn on and off of function setting. Courses suggested by students showed that the materials can be used

for courses in other teaching programmes that cover the same topic. New topics suggested will take into consideration for future development.

Feedback also supported the flipped classroom approach of teaching and learning. VR biomolecules are suitable for studying at home as pre-class preparation.

Most of the students agreed that VR biomolecules increase their motivation and engagement of learning and VR biomolecules provide them a fast and flexible way to understand biomolecules which are our expected outcome.

4. Dissemination, diffusion and impact

Please provide examples of dissemination: website, presentations in workshops or conferences, or publications.
Please provide examples of diffusion: how the project results/process/outcomes/deliverables have been used in your unit and other parts of CUHK or other institutions?
Please provide examples of impact: how the project results can be adapted to other disciplines.

The finished mobile app is uploaded to Apps Store and Google Play for download and install as stated in the following link, new version will be updated from time to time.

For IOS, scan QR code or go to website below:
https://itunes.apple.com/us/app/vr-biomolecules/id1337514673?ls=1&mt=8

For Android, scan QR code or go to website below:
https://play.google.com/store/apps/details?id=hk.edu.cuhk.sls.VRBiomolecules

Students taking courses Molecular Biology (BCHE3050 and BCHE4010), Molecular Biology and Recombinant DNA Laboratory (BCHE3650) will be asked to use the app to supplement their studies in 2018/19. Information of this Virtual molecules will be announced in the centralized e-learning website of Biochemistry Programme (www.bch.cuhk.edu.hk/learnbiochem), for students of other courses to get access to. Teachers of other programmes teaching similar contents will be informed.

PART II

Financial data

Funds available:

Funds awarded from CDG $ 70000

Funds secured from other sources $ _____
(please specify_____)

Total: $ 70000

Expenditure:

Item	Budget as per application	Expenditure	Balance
Salary of Student helpers		HK$4706.65	
IT development service (ITSC) + VR glasses		HK$50,657	
Research materials		HK$14636.35	
Total:		HK$70,000	

PART III

Lessons learnt from the project

Please describe your way forward.
Please describe any of the following item(s) accordingly:

- *Key success factors, if any*
- *Difficulties encountered and remedial actions taken, if any*
- *The role of other units in providing support, if any*
- *Suggestions to CUHK, if any*
    - *Example: what should be done differently?*

Partnered with ITSC during the VR biomolecules development stage, we encountered difficulty in software compatibility in converting 3D graphics files into another platform for VR development. Therefore, it took longer time in the development stage to fix software compatibility issue. Another problem we faced are long loading time to start some complicated VR molecules in the mobile app. Because of the large file size will impact on the loading time of VR molecules, more complicated the molecules, larger the size and hence longer the loading time. To strike for the balance, we eventually kept the molecules not too complicated for optimal performance.

From the feedback of the focus group, we observed there is a high demand of more VR models on more topics to cover different courses of study. This kind of tools provides them a fast and effective means in learning. It is suitable for e-learning and flipped classroom. Therefore, we also suggest that more resources should be allocated to projects for VR development.

PART IV

Information for public access

Summary information and brief write-ups of individual projects will be uploaded to a publicly accessible CUHK CDG website. Please extract from Part I the relevant information to facilitate the compilation of the publicly accessible website and reports.

This project is to generate a collection of virtual molecules for the Molecular Biology course aiming to help students understand the three-dimensional structures and the molecular interactions of some important biomolecules. While the traditional classroom uses diagrams and models to represent the biomolecules, student engagement in learning molecular biology can be enhanced by application of virtual-reality technologies such that students can manipulate molecules, see the molecular structures in three-dimensional space interactively. This serves to increase

their motivation and engagement of learning.

22 virtual biomolecules are generated. The molecules are labeled for important atoms and dimensions on bond length and atom. There is a brief description for each molecule, followed by revision MC questions for the biomolecules. A mobile app (named VR Biomolecules) has been developed which allows students to get access to the molecules through Mobile device, in both Android or iOS, and VR head-mounted display sets.

A focus group was formed to evaluate the virtual molecules and accompanied exercises. Most of the students agreed that VR biomolecules increase their motivation and engagement of learning and VR biomolecules provide them a fast and flexible way to understand biomolecules. Students showed that the materials can be used for courses in other teaching programmes that cover the same topic.

The finished mobile app (VR Biomolecules) is uploaded to Apps Store and Google Play for download and install. Information of these virtual molecules will be announced in the centralized e-learning website of the Biochemistry Programme (www.bch.cuhk.edu.hk/learnbiochem)

In 2018/19, CUHK Students taking Molecular Biology course (BCHE3050) and Molecular Biology and Recombinant DNA Laboratory (BCHE3650) will be asked to use the app to supplement their studies.

1. Keywords

Please provide five keywords (in the order of relevance to your project) to describe your project.

(Most relevant) Keyword 1: Virtual reality

Keyword 2: Biomolecules

Keyword 3: Molecular biology

Keyword 4: e-learning

(Least relevant) Keyword 5: Mobile app

2. Summary statistics

Please provide information, if any, in the following tables, and provide the details in Part I.

Table 1: Publicly accessible online resources (if any)
(a) **Project website: nil**

If a publicly accessible project website has been constructed, please provide the URL
(b) **Webpage(s):** *If information of your project is summarized in a webpage (say a page in the department's or faculty's website), please provide the URL(s) in here*
(c) **Others (please specify):** Install the apps with the following link: IOS: https://itunes.apple.com/us/app/vr-biomolecules/id1337514673?ls=1&mt=8 Android: https://play.google.com/store/apps/details?id=hk.edu.cuhk.sls.VRBiomolecules

Table 2: Resource accessible to a target group of students (if any)

If resources (e.g. software) have been developed for a target group of students (e.g. in a course, in a department) to gain access through specific platforms (e.g. CU Learning Management System (Blackboard), facebook), please specify.

Course Code/ Target Students	**Term & Year of offering**	**Approximate No. of students**	**Platform**
BCHE3050, BCHE3650	2nd term, year 3	90	Blackboard, mobile app

Table 3: Presentation (if any) **nil**	
Please classify each of the (oral/poster) presentations into one and only one of the following categories	**Number**
(a) In workshop/retreat within your unit (e.g. department, faculty)	*Please insert no*
(b) In workshop/retreat organized for CUHK teachers (e.g. CLEAR workshop, workshop organized by other CUHK units)	*Please insert no*

(c) In CUHK ExPo jointly organized by CLEAR and ITSC	*Please insert no*
(d) In any other event held in HK (e.g. UGC symposium, talks delivered to units of other institutions)	*Please insert no*
(e) In international conference	*Please insert no*
(f) Others (please specify)	*Please insert no*

Table 4: Publication (if any) **nil**	
Please classify each piece of publications into one and only one of the following categories	**Number**
(a) Project CD/DVD	*Please insert no*
(b) Project leaflet	*Please insert no*
(c) Project booklet	*Please insert no*
(d) A section/chapter in a booklet/book distributed to a limited group of audience	*Please insert no*
(e) Conference proceeding	*Please insert no*
(f) A chapter in a book accessible internationally	*Please insert no*
(g) A paper in refereed journal	*Please insert no*
(h) Others (please specify)	*Please insert no*