

HUBS/HUCBMS Workshop

# Overcoming Barriers in Chemistry Teaching within the Biosciences

University of Bradford

1<sup>st</sup> July 2019



## **Workshop Programme**

Norcroft Auditorium, Conference Centre, University of Bradford

9:00 *Registration and Coffee*

**10:00 Welcome**

**10:15 Challenges Teaching Chemistry for Natural Sciences and Biology Programmes**

Nicholas Chatterton, Open University

**10:30 Chemistry Teaching Barriers for Biomedical Science Programmes**

Anne Graham, University of Bradford

**10:50 Group Discussion: Identifying and Overcoming Barriers**

Chair: Gisela Helfer

**11:20 Summary**

11:30 *Coffee Break*

**11:50 Barrier-crossing with technology**

Clare Towse and John Fairhall, University of Bradford

**12:10 How to tackle the math problem?**

Pam Dunn, Harrogate and District NHS Foundation Trust

12:30 *Lunch*

**13:30 – 15:45 Afternoon Group Sessions**

**If they can see it, we can teach it**

Clare Towse, JB Priestley Building, room 01.53

- Using open source software to create Augmented Reality materials

**Pedagogy Alchemy**

Philip Drake, Norcroft Auditorium

- How the teaching pedagogy of a chemist teaching chemistry differs from approaches taken on biomedical and bioscience programmes

**The Art of The Possible**

John Fairhall, Student Central Building, room SC0.51

- Explore the use of high-end Virtual Reality technologies to teach chemistry

*Return to Norcroft Auditorium*

**15:45 Group Discussion: Overcoming Barriers: What next?**

Chair: Clare Towse

**16:00 Close**

## Afternoon Sessions

Three sessions will run in parallel during the afternoon from 1.30 pm until 3.45 pm. Two of the sessions will share technological approaches used or being trialled at Bradford, *i.e.* augmented, virtual and mixed realities, to improve cross-disciplinary teaching of chemistry and biology. In these sessions, you will be shown how using AR and VR can convey chemistry in a more accessible way and will be given an opportunity to create your own material. The third session will be led by a synthetic chemist who will discuss and demonstrate the differences in how chemists might tackle teaching tricky chemistry topics compared with approaches used by biologists or biomedical scientists.

Session	Location	1:30 – 2:10	2:15 – 2:55	3:00 – 3:40
If they can see it, we can teach it	JBPL 01.53	Group A	Group B	Group C
Pedagogy Alchemy	Norcroft Auditorium	Group B	Group C	Group A
The Art of the Possible	SC0.51	Group C	Group A	Group B

Attendees will be assigned to one of three groups to ensure everyone gets to experience each of these sessions. Group information can be found on a separate sheet within your workshop pack.

## Room Locations

A map is provided in your workshop packs with the buildings labelled. However, within each group there will be a member of University of Bradford staff who will escort you to the correct rooms.

Rooms being used for the afternoon sessions are:

- Norcroft Auditorium, located in the Conference Centre Building
- SC0.51, located in the Student Central Building
- JBPL 01.53, located in the J B Priestley Building (Library)

## Pedagogy Alchemy

Philip Drake  
Auditorium

Location: Norcroft

A chemist's perspective on biomolecules and an examination of differences between the teaching pedagogy of a chemist teaching chemistry and that of non-chemists.

One of the repeated concerns of students studying biomedical sciences, biology, and related subjects, is the need to 'remember' the many different organic structures of biomolecules. If biomolecules are the interface between chemistry and biology, it is perhaps interesting to think about the routes that a chemist and a biologist would take to get to that meeting point.

A biological perspective will, by necessity, consider a 'macro' view of any given biochemical process, whereas an organic chemist would always describe an event in terms of the interactions between specific functional groups on specific molecules. This different way of looking at the world has led to different approaches to teaching the underlying chemistry associated with biomolecules.

In chemistry, we too have complaints from students about the number of different chemical structures they are 'expected' to know. Our approach to tackling this issue is to get students in the first year to learn the 'language' of organic chemistry – to recognise and understand the chemistry of specific functional groups, and thus be in a position to predict the reactivity of molecules unfamiliar to them. In this session we will explore this approach and discuss whether it is appropriate or desirable in a more biology focussed course to spend the time learning the alphabet so as to avoid having to memorise the words.

## The Art of The Possible

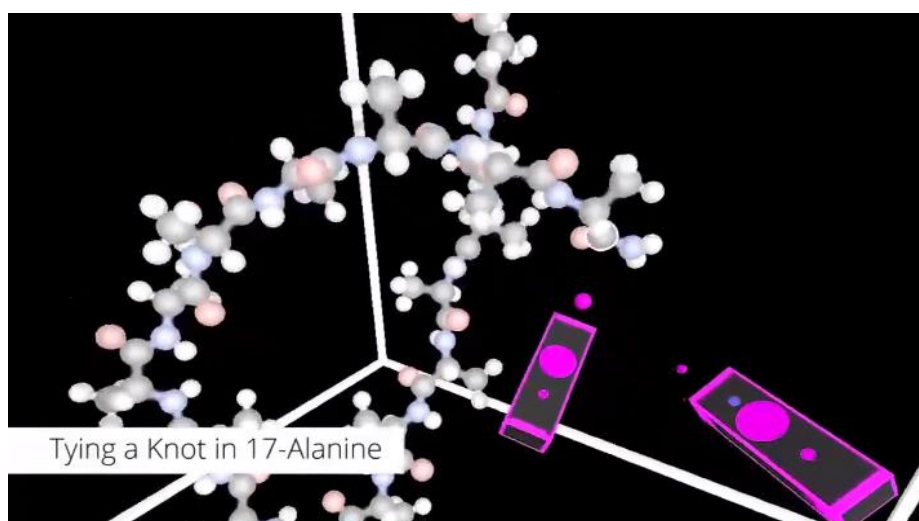
John Fairhall

Location: Student Central SC0.51

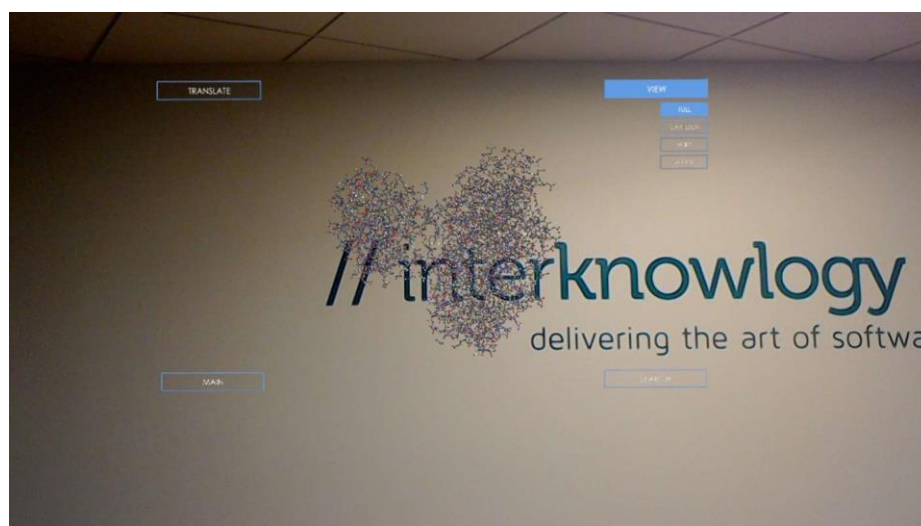
A hands-on interactive session where delegates will have the opportunity to try out high-end extended reality technologies, discover how they can be applied in relation to teaching and research in the subject of chemistry, as well as discuss possibilities with a technology specialist.

In this session you will:

1. Use NanoSimbox with a HTC Vive to tie a knot in a small protein in Virtual Reality:



2. Use Holocule on a Microsoft Hololens to walk around a virus particle in Mixed Reality:



By the end of this session, delegates will have a better understanding of:

- how extended reality technologies (XR) are being applied in Chemistry teaching and research;
- the differences between the technologies and the pros and cons of each;
- what's needed to implement the technologies within an institution.

## If they can see it, we can teach it

Clare Towse  
Cluster

Location: JBPL 01.53 PC

This session is a hands-on tutorial to create AR content using open source software and 3D models to highlight the chemistry within biomolecules to help students overcome the challenge of linking chemistry to biomolecular structure and function.

By the end of this session, delegates will:

- 1) have learnt to access experimental structural data via a visualisation software package
- 2) manipulated biomolecule structures to highlight key features
- 3) created 3D model files and image files to generate augmented reality material
- 4) have learnt to use a specialist online site to convert augmented reality into embeddable website content (e.g. using canvas) and to create virtual reality models

### Computer Login

Username: pcuser18  
Password: Apple123

### Instructions for creating an Augmented Reality Model

These instructions can also be found on:

<https://v3.pebblepad.co.uk/spa/#/public/8t8rpy6pw3ndrz4q5s59wm4x3h>

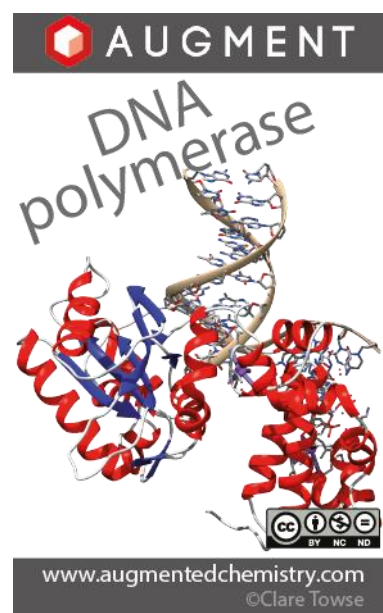
### Producing Augmented Reality (AR) Scannable Images

Images can be created that when scanned with a phone produces a 3D model as if it were in the room. These images can be presented on handouts or scanned from PC and projector screens (depending on screen quality).

*Demonstration:*

1. Search for 'augment' on the Google Play or Apple Store apps on your phone. Download and install the free app.
2. Using the app, scan the image shown to the right (a model of the enzyme DNA polymerase replicating DNA).

This is referred to as a **tracker image** and is linked to a specific AR model.



Next, we will take you through how to create your own 3D models using a piece of free software called **UCSF Chimera**. We will then show you how this can be turned into an AR model using the free **AUGMENT** and **SketchFab** websites.

## ***Installing Chimera***

The software you need today is already installed, go to the start menu and search for UCSF Chimera.

If you wish to try out this tutorial at home:

1. Download UCSF Chimera (free software).

Go to <https://www.cgl.ucsf.edu/chimera/download.html> and download the Windows 64-bit .exe file (or Mac or Linux packages, depending on your system).



2. Once installed, open UCSF Chimera via the Start Menu or Desktop Icon

## ***Creating a 3D model in UCSF Chimera***

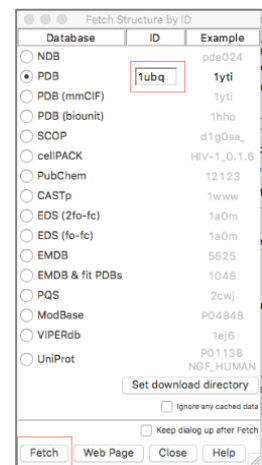
1. Go to the **File** menu --> **Fetch by ID...**

A popup window will appear named "Fetch Structure by ID".

2. Type **1ubq** in the popup window next to **PDB** and click on the **Fetch** button.

PDB stands for Protein Data Bank and houses all experimentally determined protein and other biomolecular structures. The 1ubq code will fetch a 3D structure of the ubiquitin protein, an important signalling protein in our bodies, solved in 1987.

An image will appear in the main Chimera window.



3. Go to **Presets** menu --> **Publication 1**. This will make the background white.

4. Go to the **Select** menu --> **Structure** --> **secondary structure** --> **strand**.

5. Then go to the **Actions** menu --> **Ribbons** --> **Hide**. Part of the structure should now disappear.

6. Go to the **Select** menu --> **Structure** --> **backbone** --> **full** and then **Actions** --> **Atoms/Bonds** --> **show**

The missing part of the structure will now reappear but showing the atoms.

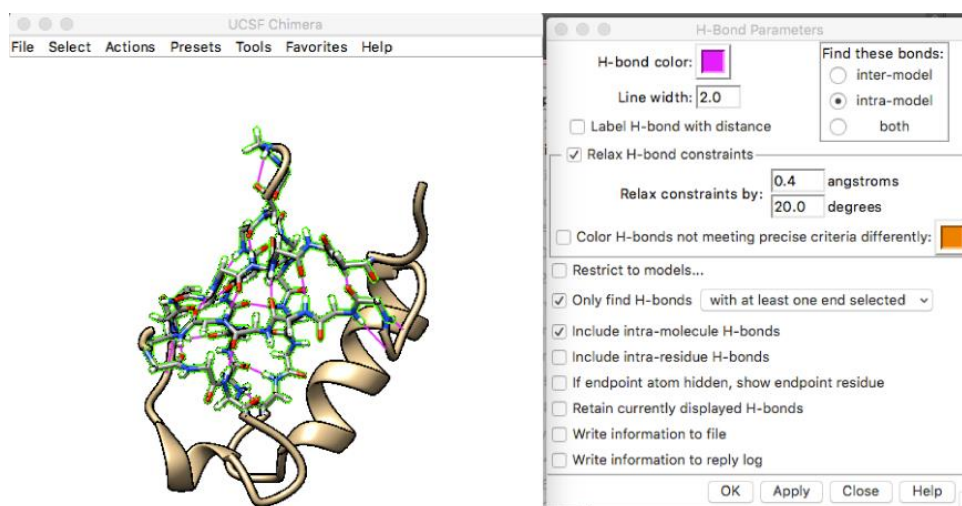
7. We can also colour the atoms by their elements.

Go to the **Actions** menu → **Color** → **by element**. Oxygen atoms are red; nitrogen atoms are blue; hydrogen atoms are white and carbon atoms are grey. You will notice there is a distinct lack of hydrogen atoms!

Some experimental structures do not have hydrogen atoms defined as the possibility to determine the hydrogen atom locations is dependent on the resolution of the data used.

8. To calculate where the hydrogens should be, go to the **Tools** menu --> **Structure Editing** --> **AddH**. A pop-up window will appear, simply hit ok. Lots of white hydrogen atoms on the highlighted beta strands should now appear.

9. Now let's look at the hydrogen bonding patterns between the beta strands. Go to the **Select** menu --> **Structure** --> **secondary structure** --> **strand**. Then, go to the **Tools** menu --> **Structure Analysis** --> **FindHbond**. Another pop-up window will appear; make sure the options selected are as shown in the image below. Then click **OK** to see all the hydrogen bonds within the beta strands appear in the purple (or other colour) selected.



For more information and further tutorials on manipulating structures in Chimera, please go to <https://www.cgl.ucsf.edu/chimera/tutorials.html>.

### ***Turning your Chimera model into AR***

1. To create an AR model you will need to save both the model and an image.

To save a 3D model: Go to the **File** menu --> **Export Scene...** --> give the file a name and save the file as a **COLLADA (.dae)** file type.

To save an image: Go to the **File** menu --> **Save image...** --> give the file a name and save the file as a **PNG (.png)** file type.



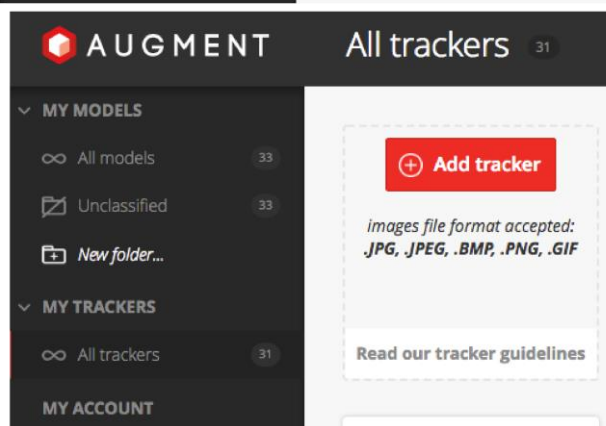
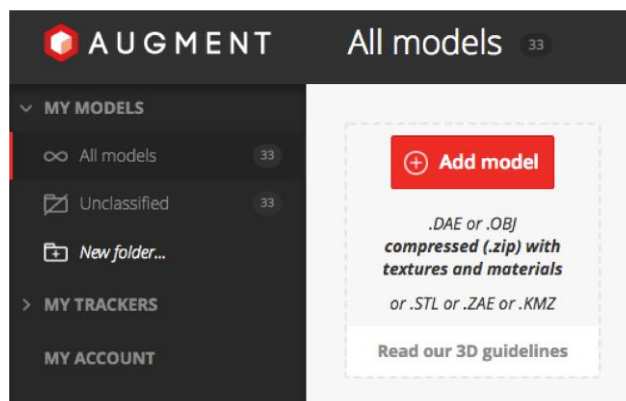
2. Go to the AUGMENT website (<https://manager.augment.com/en>) and create a free account.

3. Upload the 3D COLLADA file under the "MY MODELS" section as a new model using the **Add model** button on the website. Add some details about what the model is when prompted and then once uploaded, you will need to click a "Confirm Unit" button that appears for the model entry.

4. Tracker images are the pictures scanned by the AUGMENT app to access the AR model.

To make a tracker image to access the AR model you have created, you need to have a unique image. (*This part may need to be tried at home, time and image software constraints, but isn't necessary to continue with the tutorial*)

Using a software application like Gimp or Adobe Illustrator, open the PNG image file of the protein you created and add some text, logos or extra details. Save your bedazzled protein image as another PNG file and upload to the AUGMENT website under the "MY TRACKERS" section as a new tracker image.



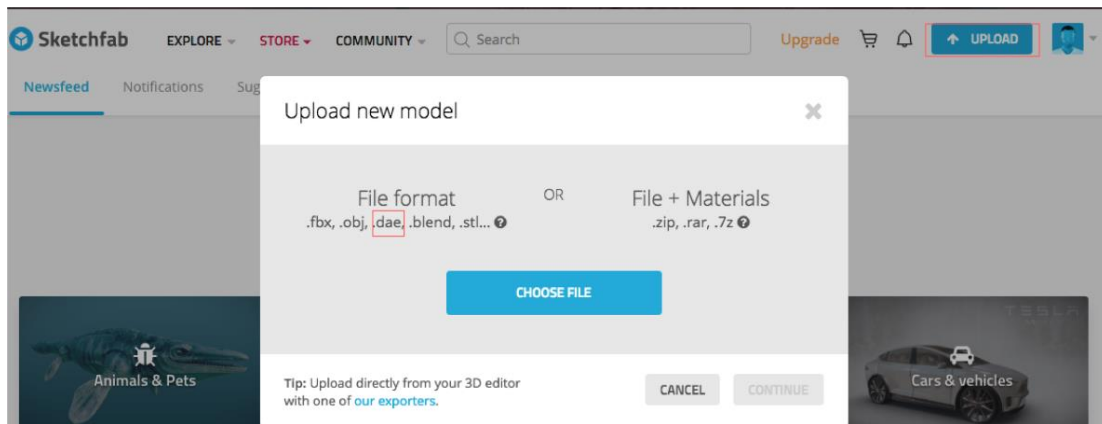
### ***Producing Augmented Reality for Online Teaching Material***

If you wish to limit or prohibit phone usage in your classes, another alternative is to produce augmented reality images that can be embedded into VLEs, such as Canvas, or into general websites. [SketchFab](https://sketchfab.com/) is an excellent tool for creating embeddable AR models and already works well with Canvas.

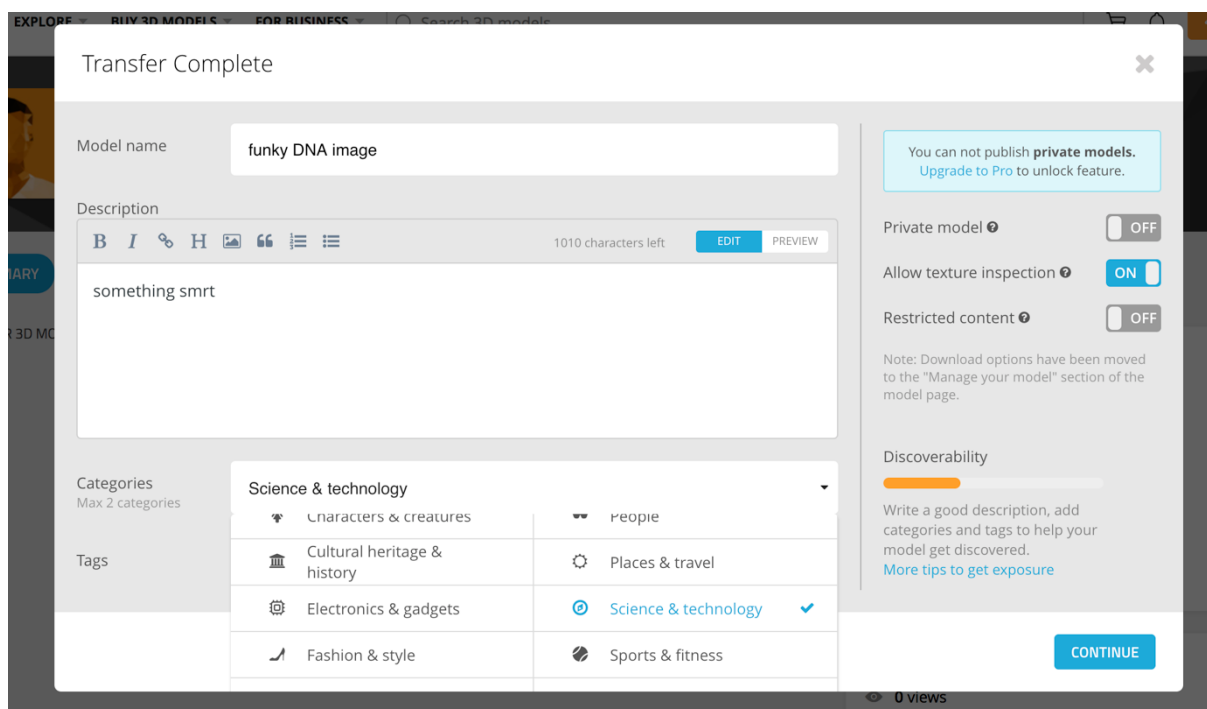
1. Go to the Sketchfab website: <https://sketchfab.com/>

2. Create a free account and login. You will be asked to pick a profile (there is a 'Scientist' option) and pick the Basic account type.

3. Click the upload button in the top right-hand corner of the screen and select your **COLLADA (.dae)** file, as shown below.



4. Another screen will appear where you can fill out the model name, a description (which helps people search for it), and select whether you want it to be a private model and what category you want it to be stored under (e.g. Science and Technology), as shown below. Then click **Continue**.



5. The next screen will show your model in AR and you should be able to move it about the screen. On the left-hand side there is an option to allow your model to be downloaded by other people, select '**Free**' and then hit the **Publish** button.

6. Once published, you can now share your model. Underneath the model image are sharing and embed functions that allow you to share links or provides you with the code needed to embed your AR scene into a VLE, such as Canvas.

With SketchFab this is all you need to do, as tracker images are not needed.

## **Viewing your model in Virtual Reality**

If you wish, the model you have just made in Sketchfab can be shown as a virtual reality model in The Art of the Possible session today.

## **Required Software and Resources Used in this Tutorial**

3D structural visualisation program, e.g. UCSF Chimera

<https://www.cgl.ucsf.edu/chimera/download.html>

Protein Data Bank (protein, peptide and nucleic acid structures + substrates)

<http://www.rcsb.org/>

Augment application and user account

<https://www.augment.com/>

Sketchfab (embedded AR and conversion to VR)

<https://sketchfab.com/>