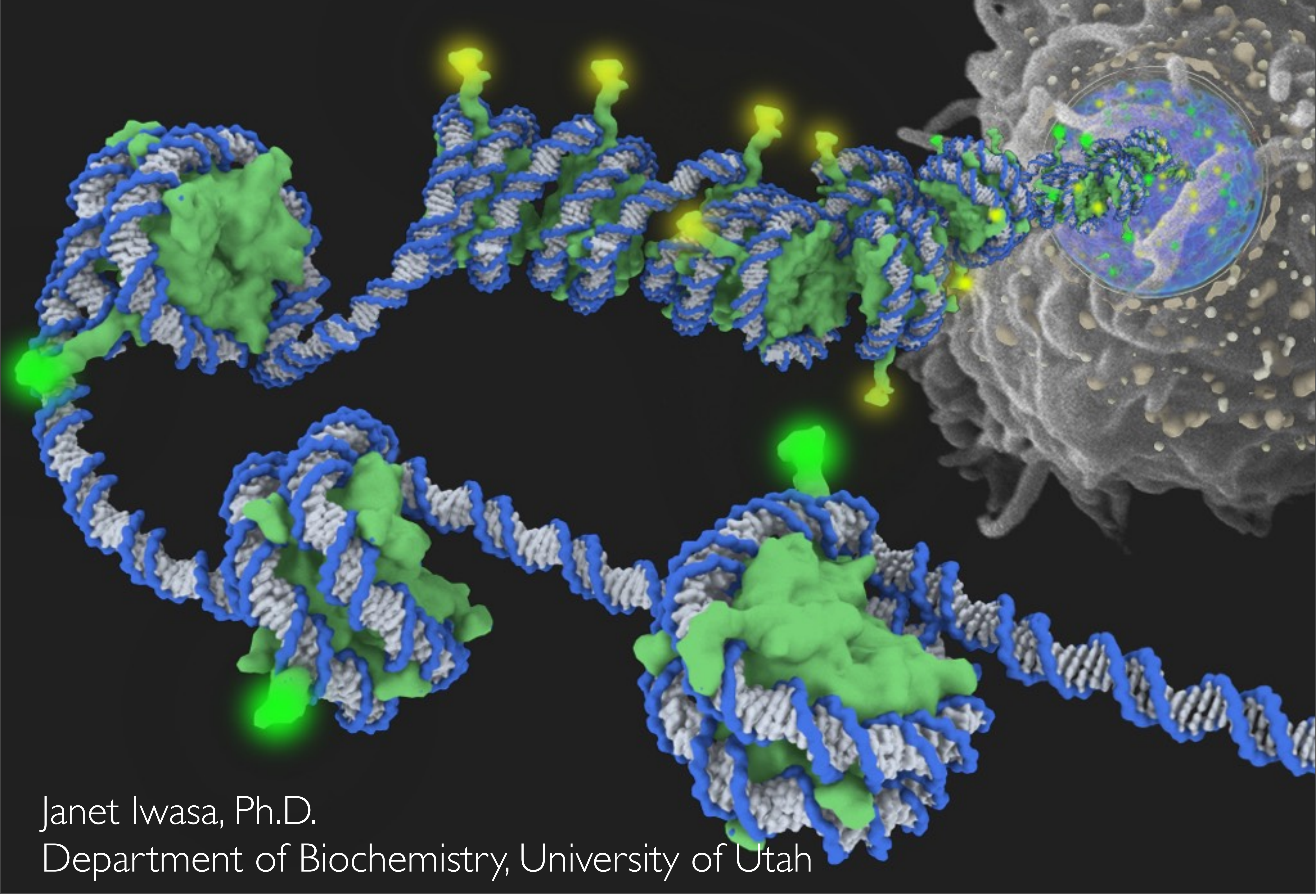
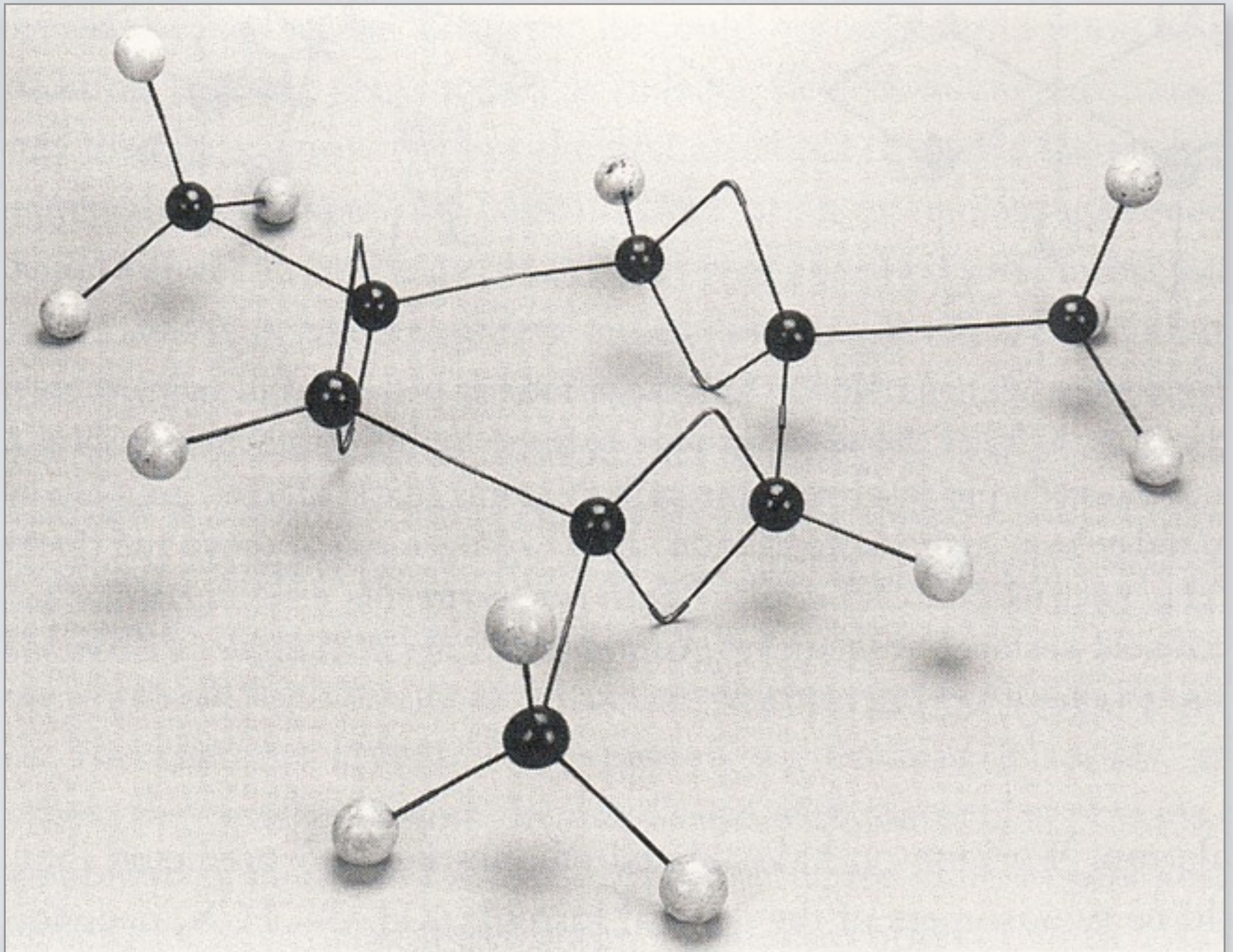
ANIMATING MOLECULES

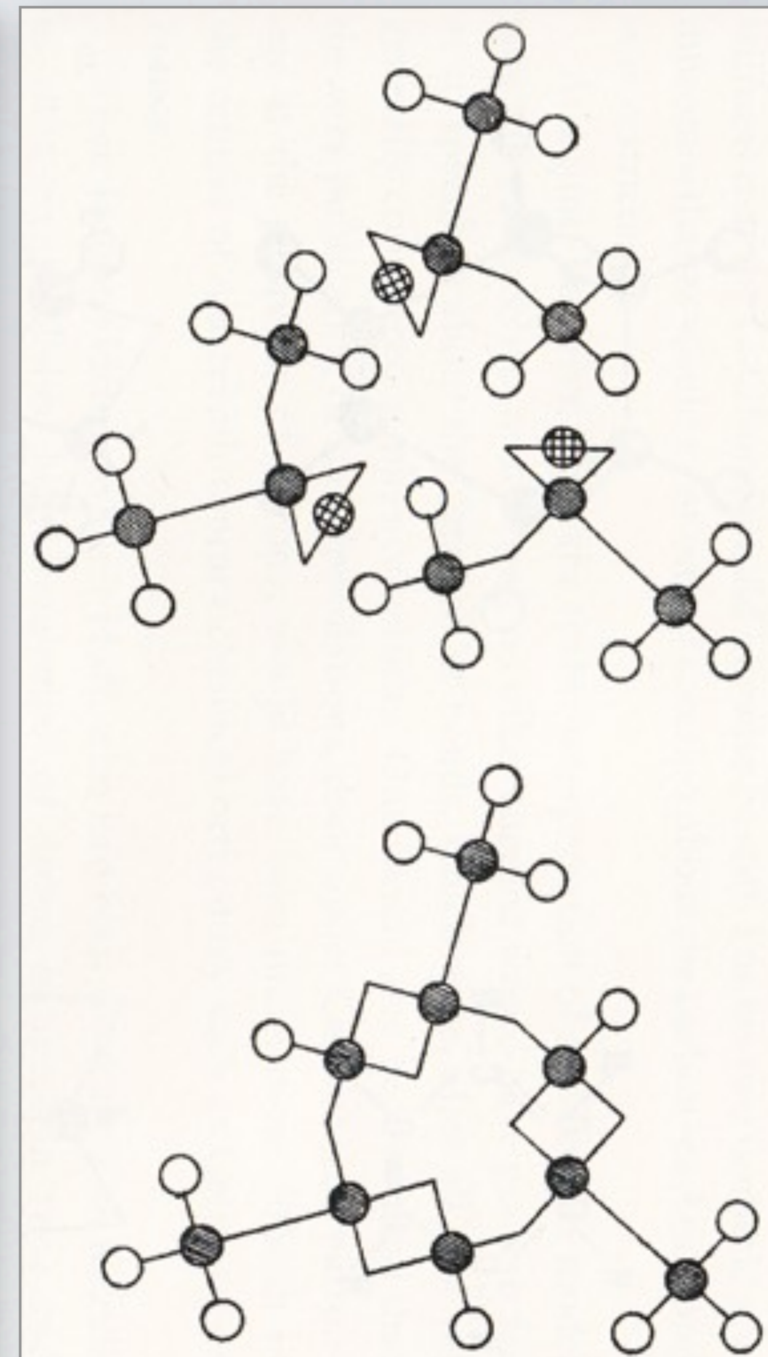


Janet Iwasa, Ph.D.
Department of Biochemistry, University of Utah

3D MODELS IN SCIENCE

Early chemical models: August Kekulé

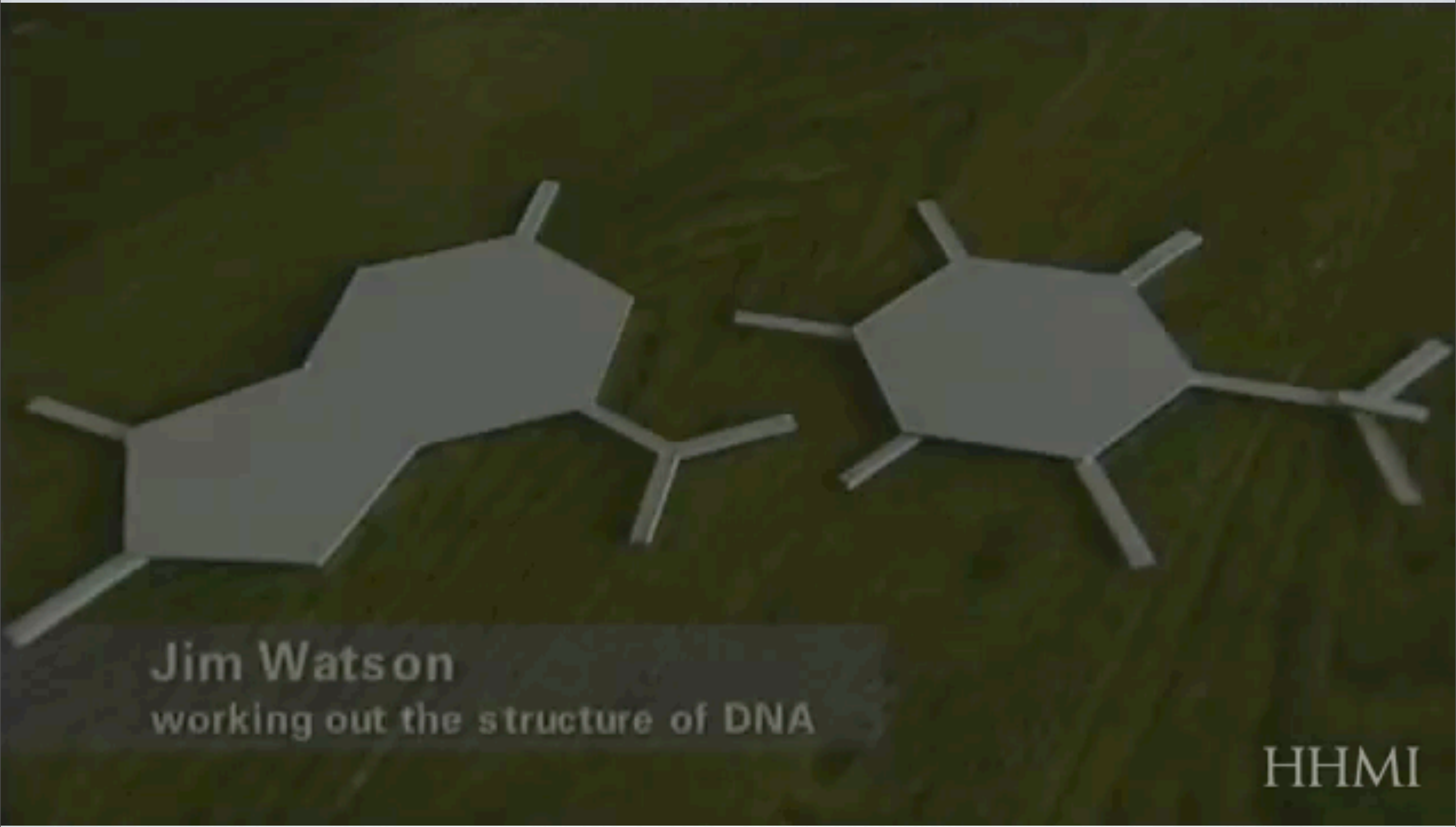




from Models: The Third Dimension of Science, edited by Soraya de Chadarevian and Nick Hopwood

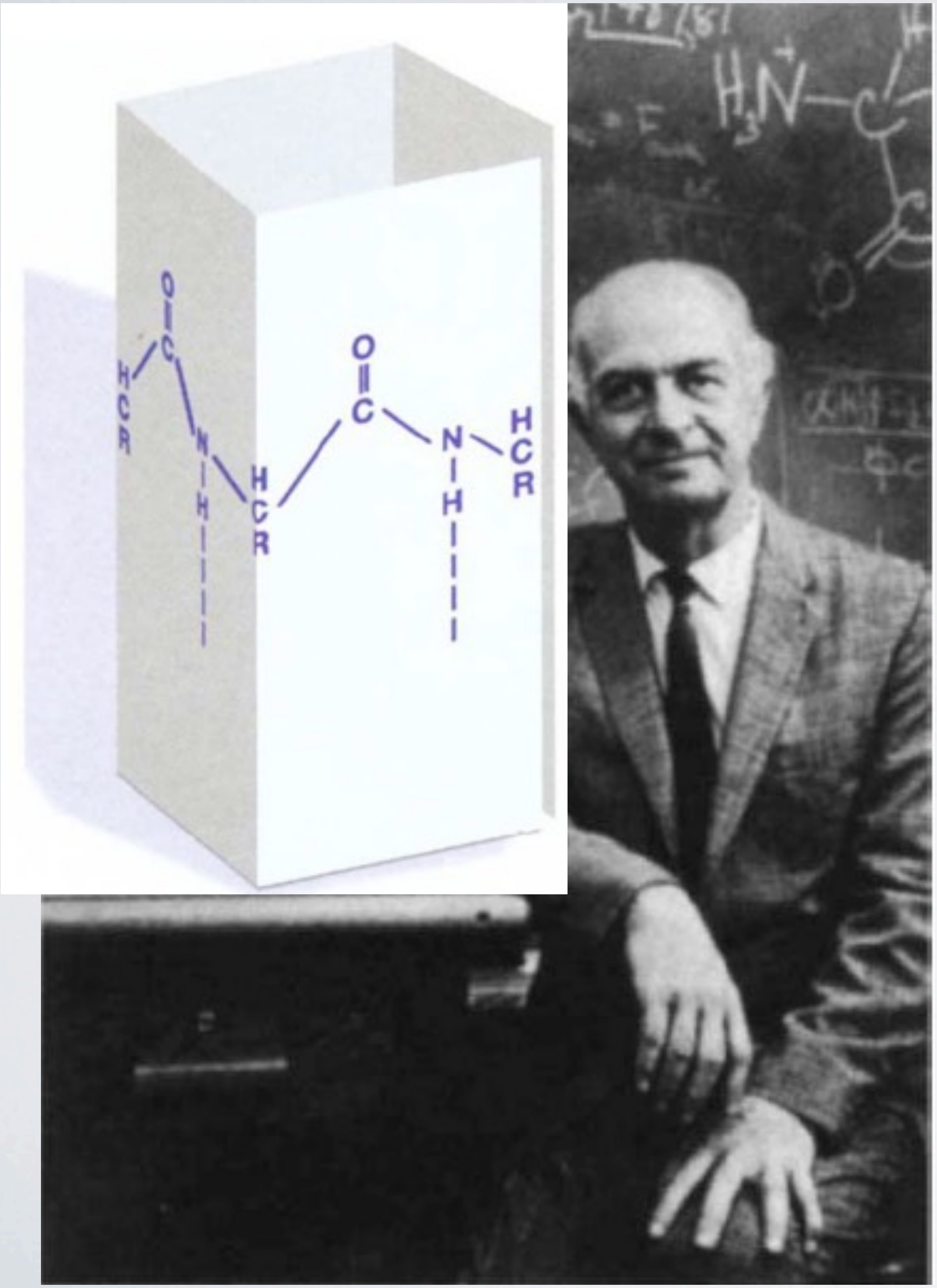
3D MODELS IN SCIENCE

James Watson with paper base pair models

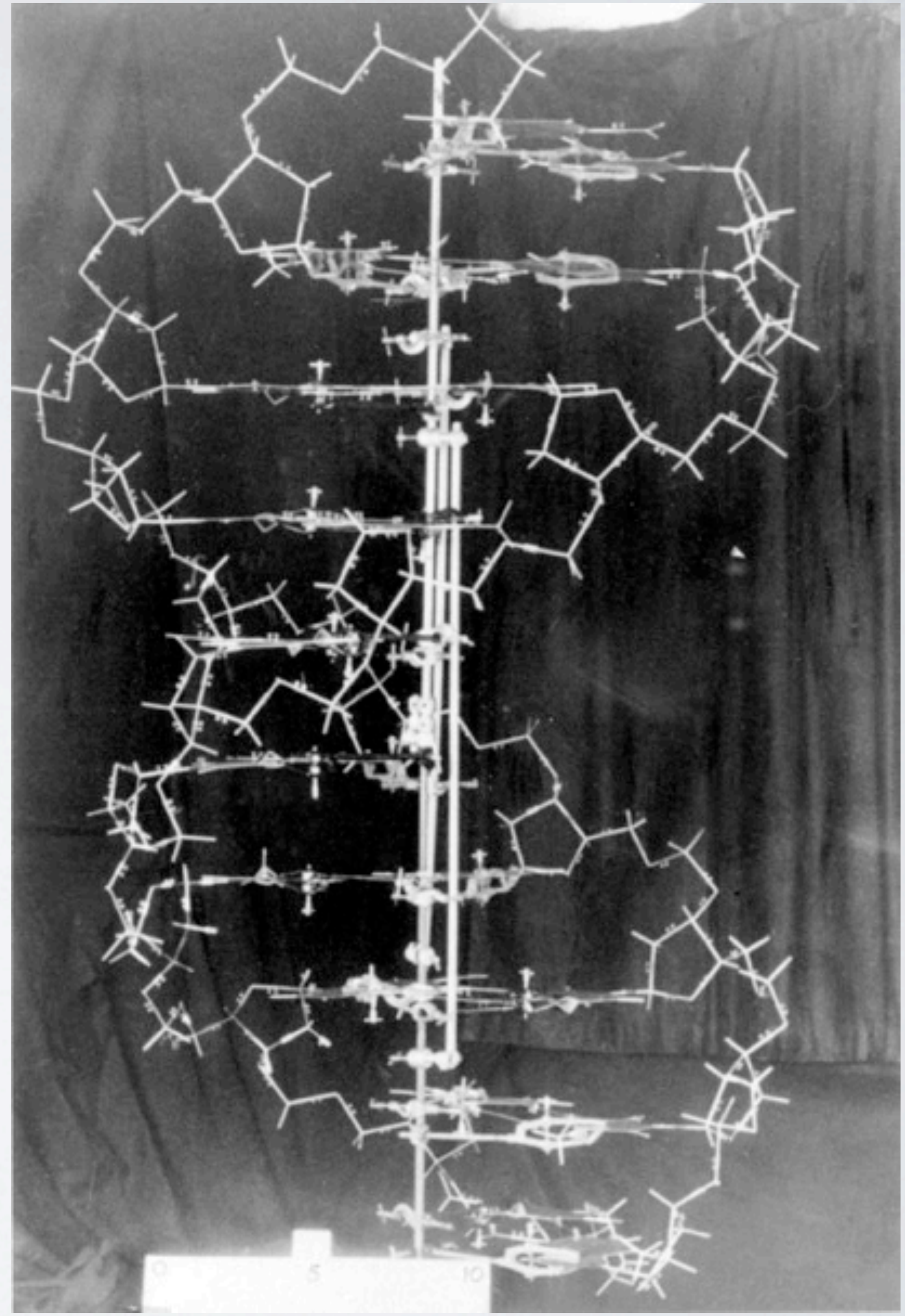


from HHMI's "Biointeractive" (http://hhmi.org/biointeractive)

ALPHA & DOUBLE HELIX



from "String and Sealing Wax" Nat Struct Biol 1997



from Cold Spring Harbor Labs

3D MODELS IN SCIENCE

1958 - Myoglobin in a "forest of rods"

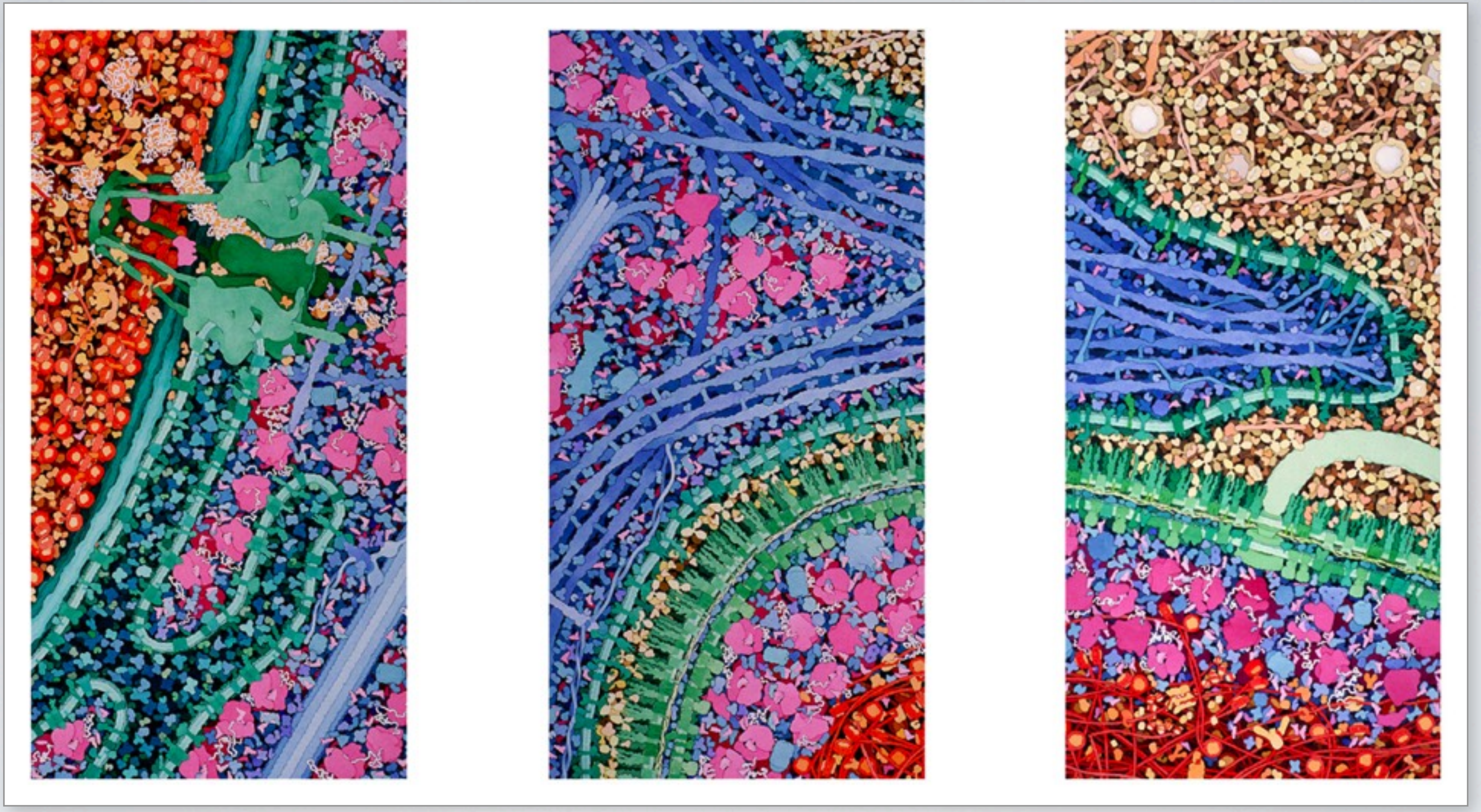
Image from: Dickerson RE. Chapter 2: myoglobin: a whale of a structure! J Mol Biol. 2009 Sep 11;392(1):10-23.

3D MODELS IN SCIENCE

Virtual models

Covers Made with Pymol - from the Pymol Wiki

VISUALIZING THE MESOSCALE



"Macrophage & Bacterium"
David Goodsell (Scripps Institute)

THE NEED FOR NEW MODELS IN BIOLOGY

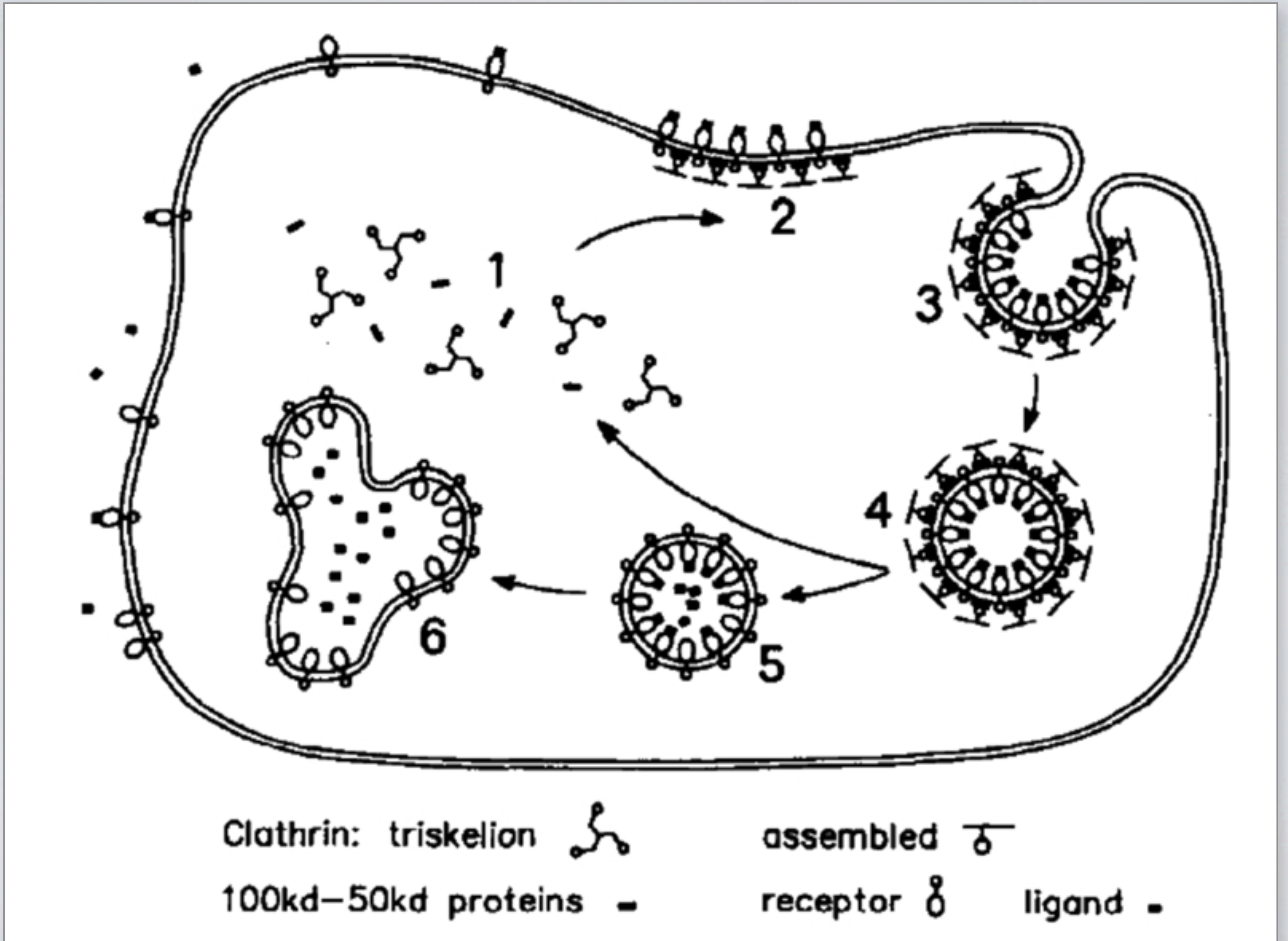
3D animation can synthesize diverse biological data ...

- protein structure
- protein activity
- dynamics
- localization
- simulation
- stoichiometry
- abundance

... allowing us to create a comprehensive visual hypothesis of a cellular event

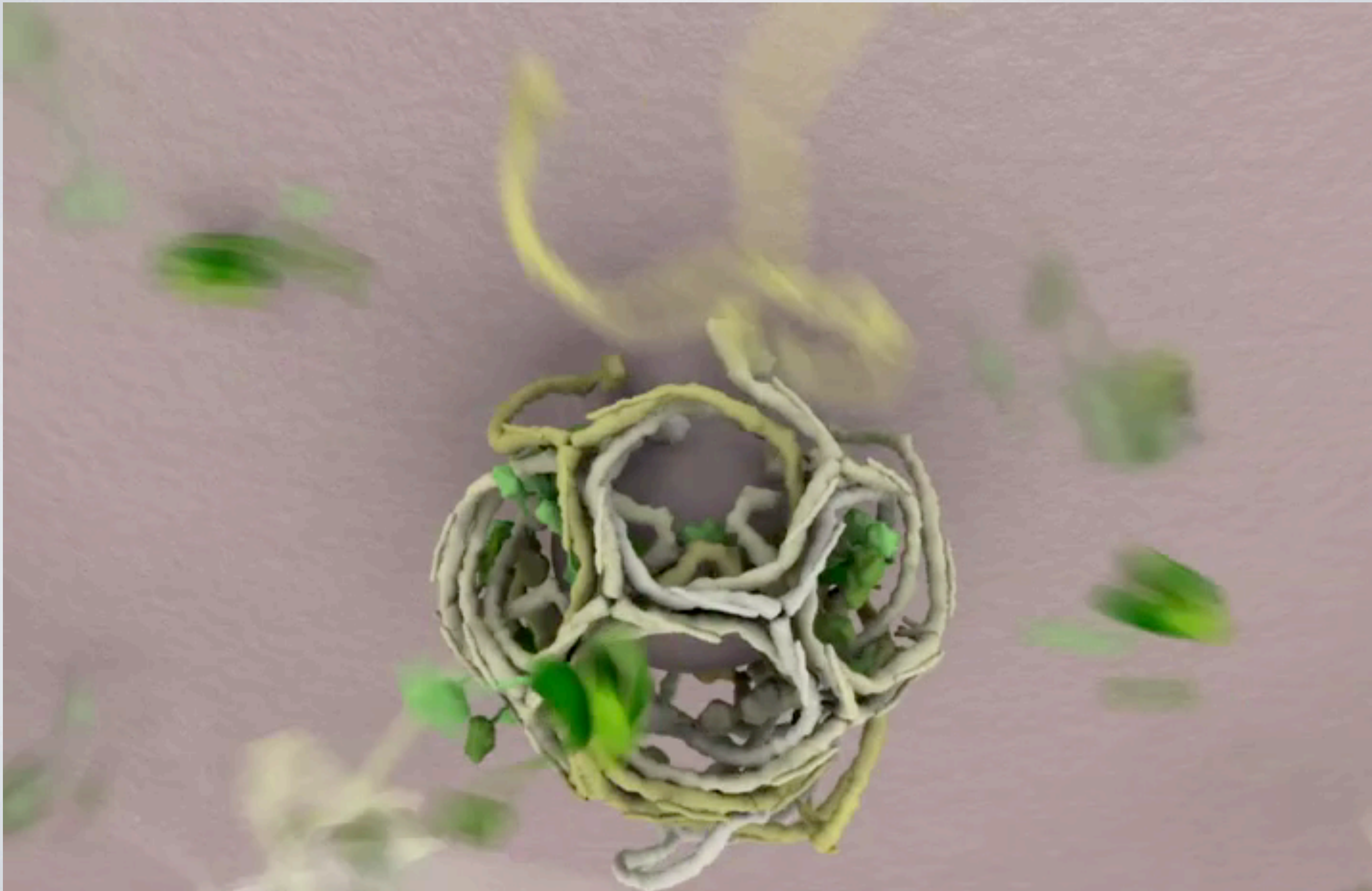
CLATHRIN MEDIATED ENDOCYTOSIS

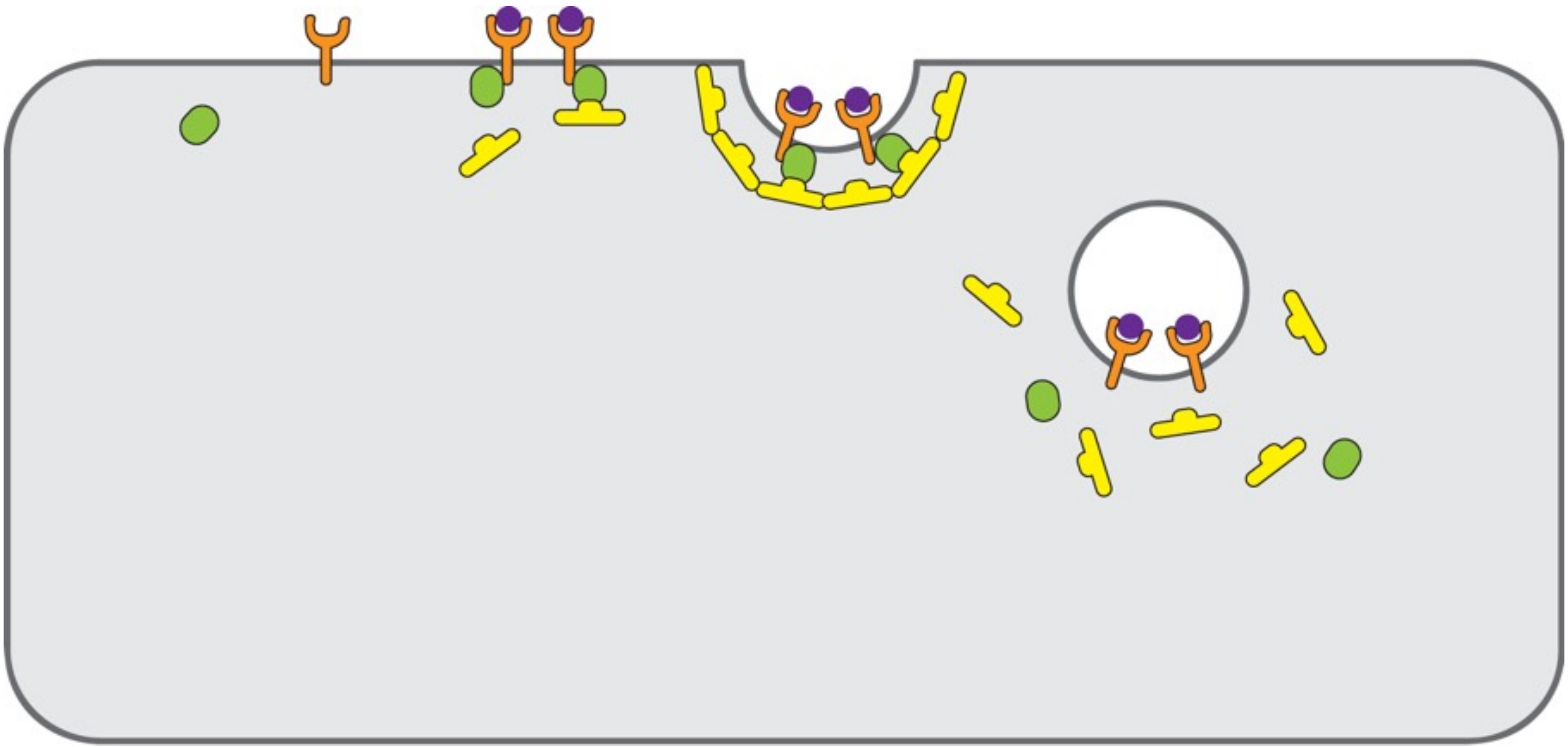
illustration by Pearse & Crowther, 1987



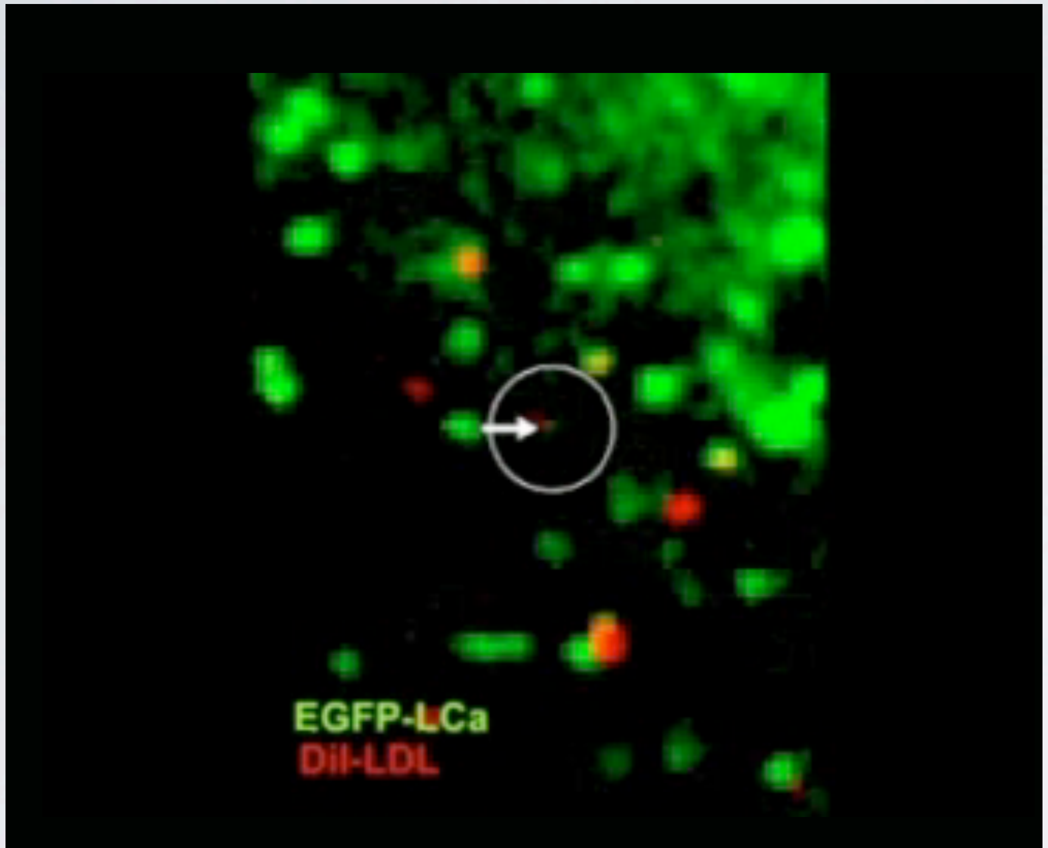
CLATHRIN MEDIATED ENDOCYTOSIS

an animation in collaboration with Tom Kirchhausen (2012)

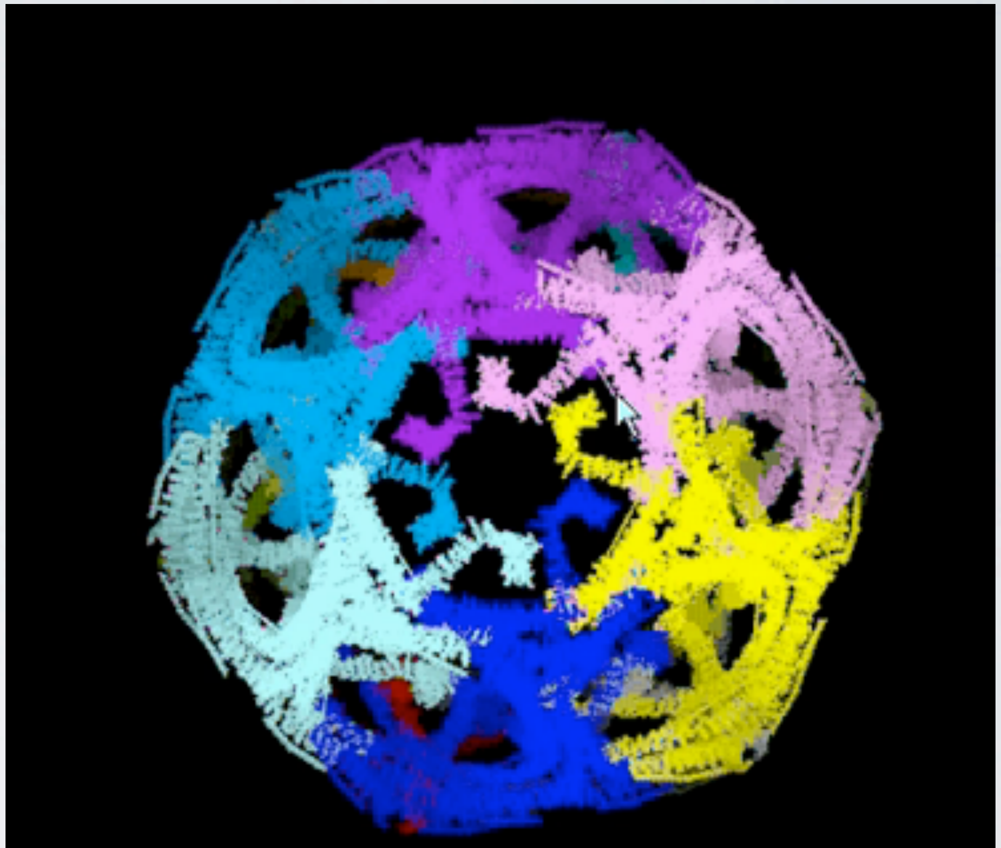


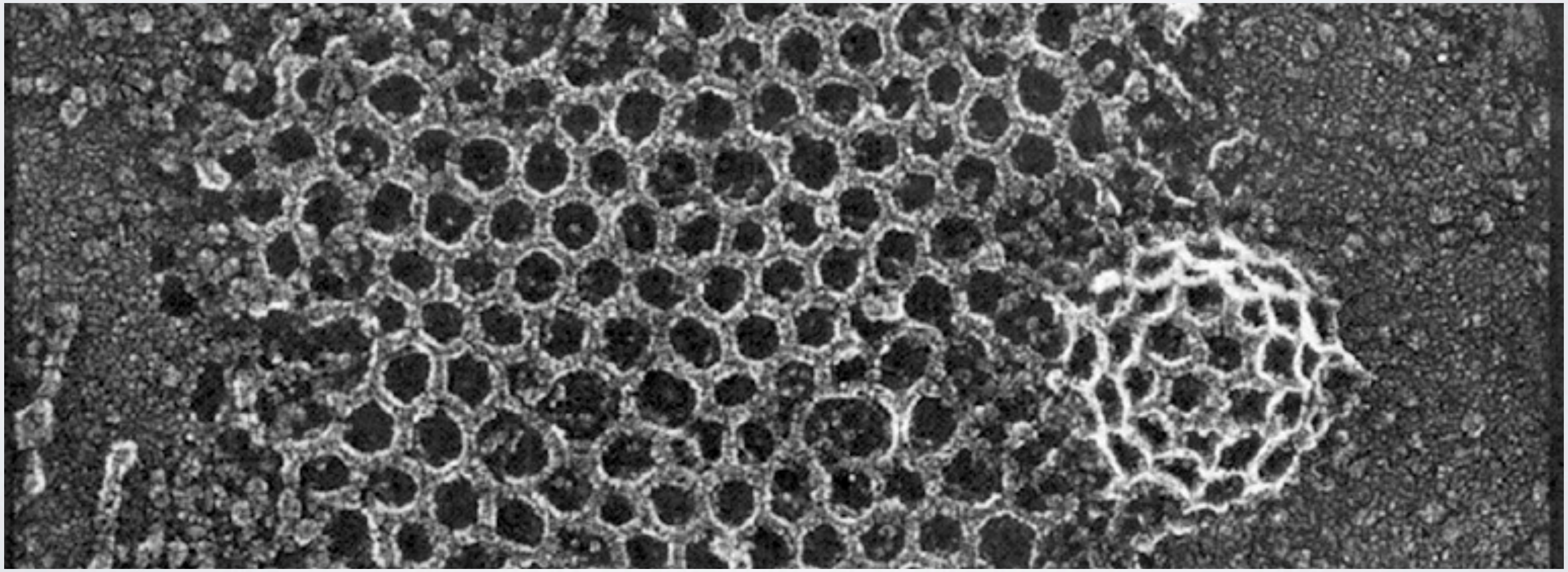


SYNTHESIS OF DIVERSE DATA

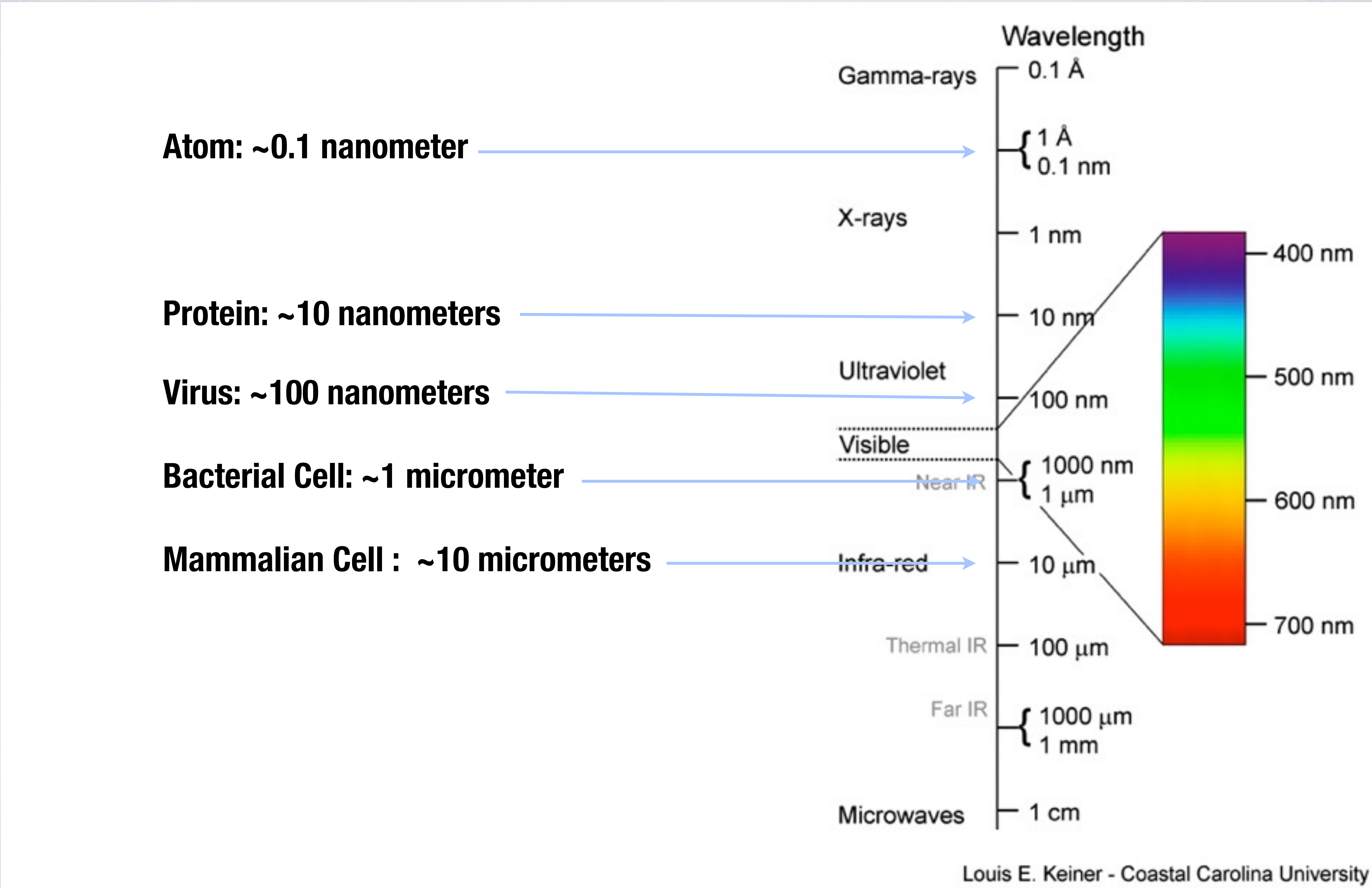


Ehrlich et al., *Cell* 2004

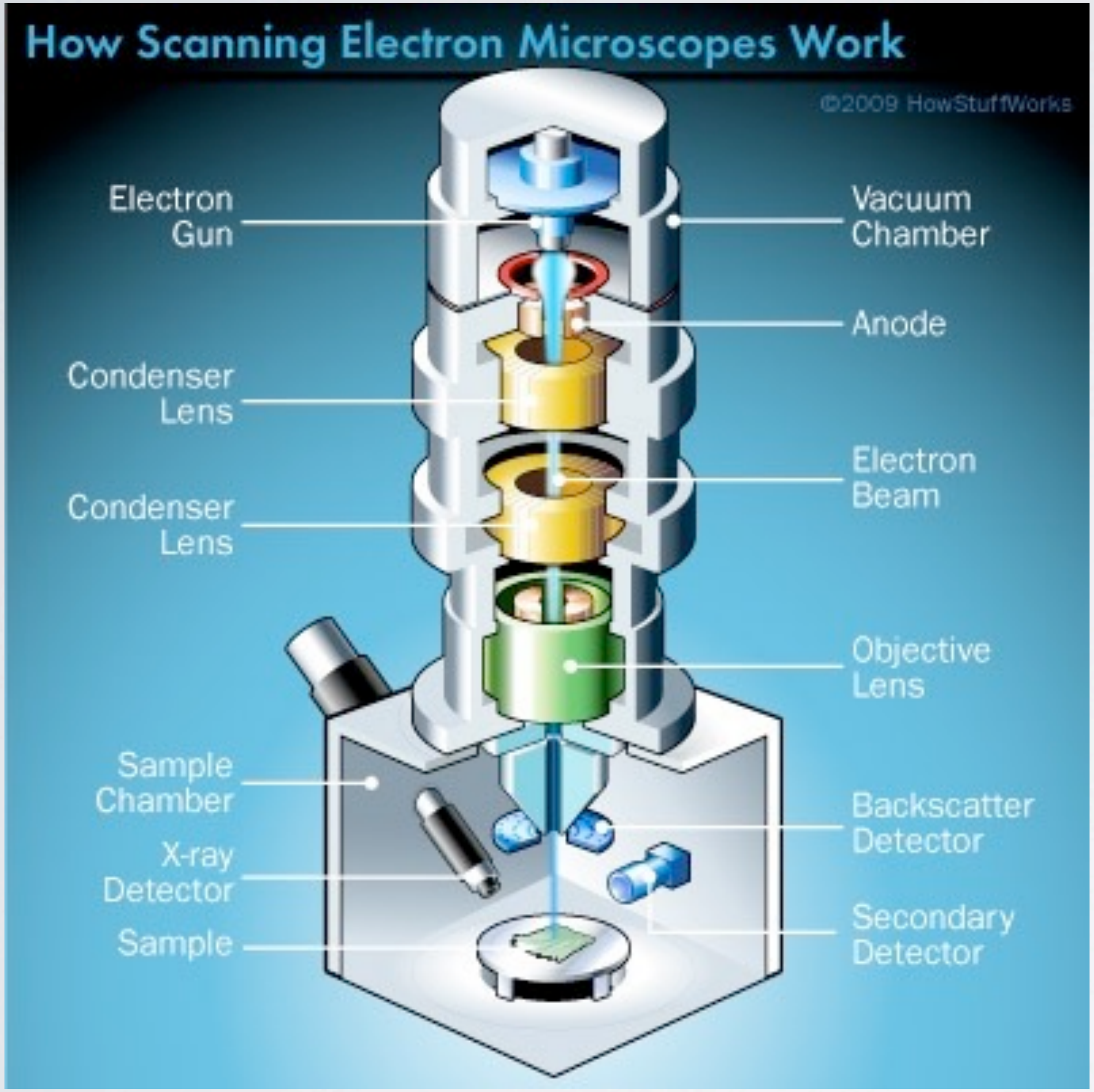

Fotin et al., *Nature* 2004


Heuser & Keen, 1998 clathrin structures on cell plasma membrane by "deep etch" electron microscopy

LIMITATIONS OF LIGHT MICROSCOPY

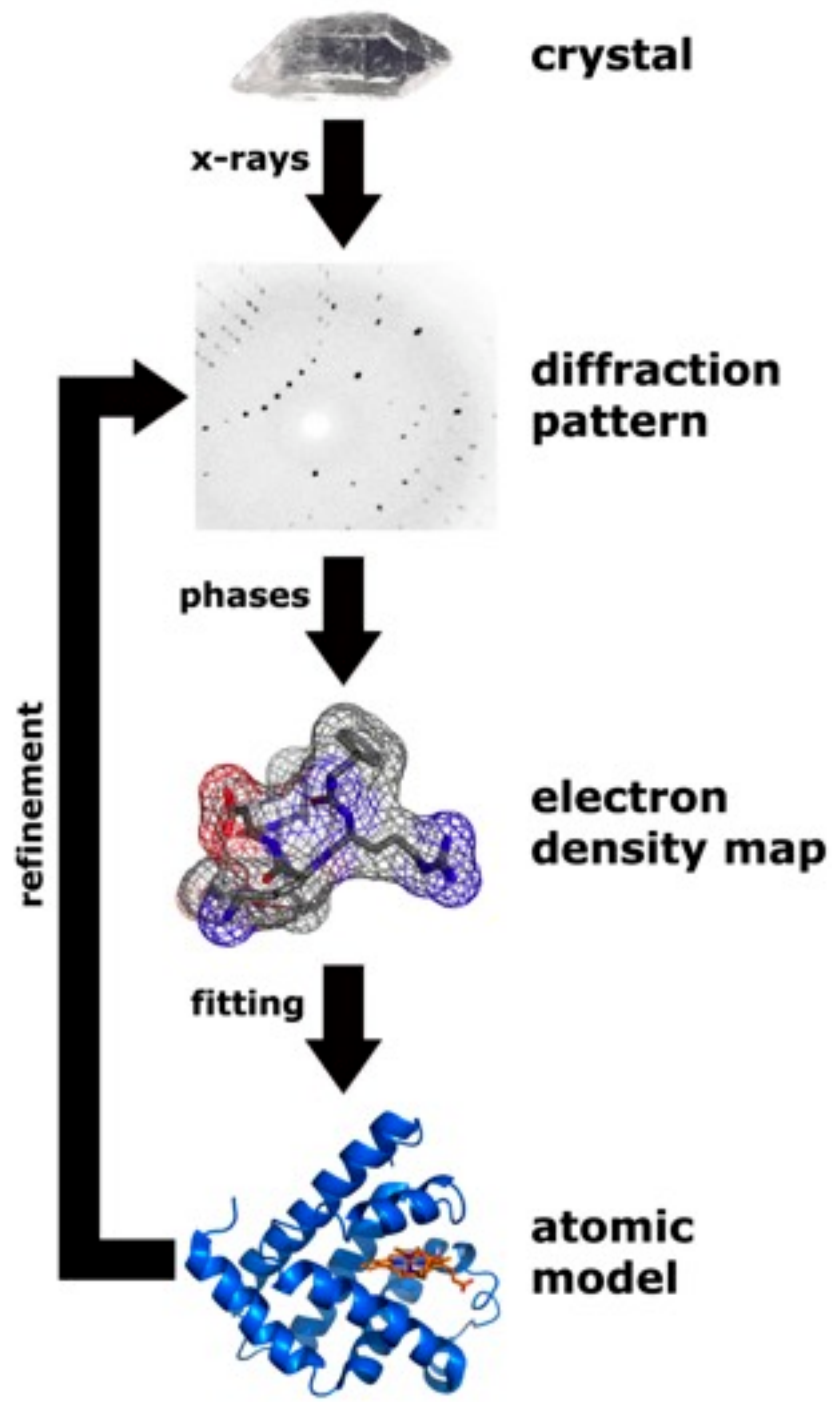


ELECTRON MICROSCOPY

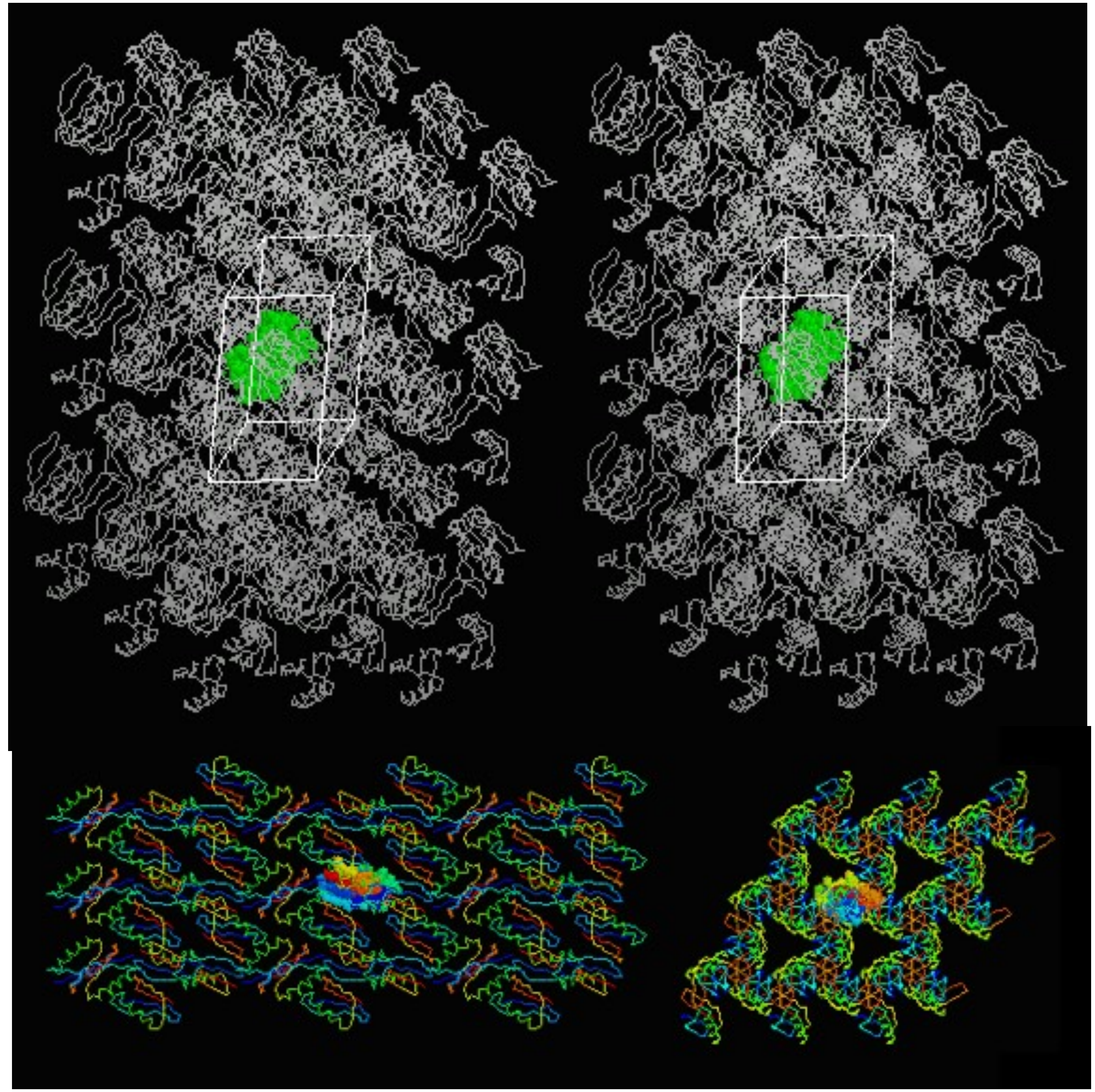


Insect coated in gold
Peter Halasz

X-RAY CRYSTALLOGRAPHY

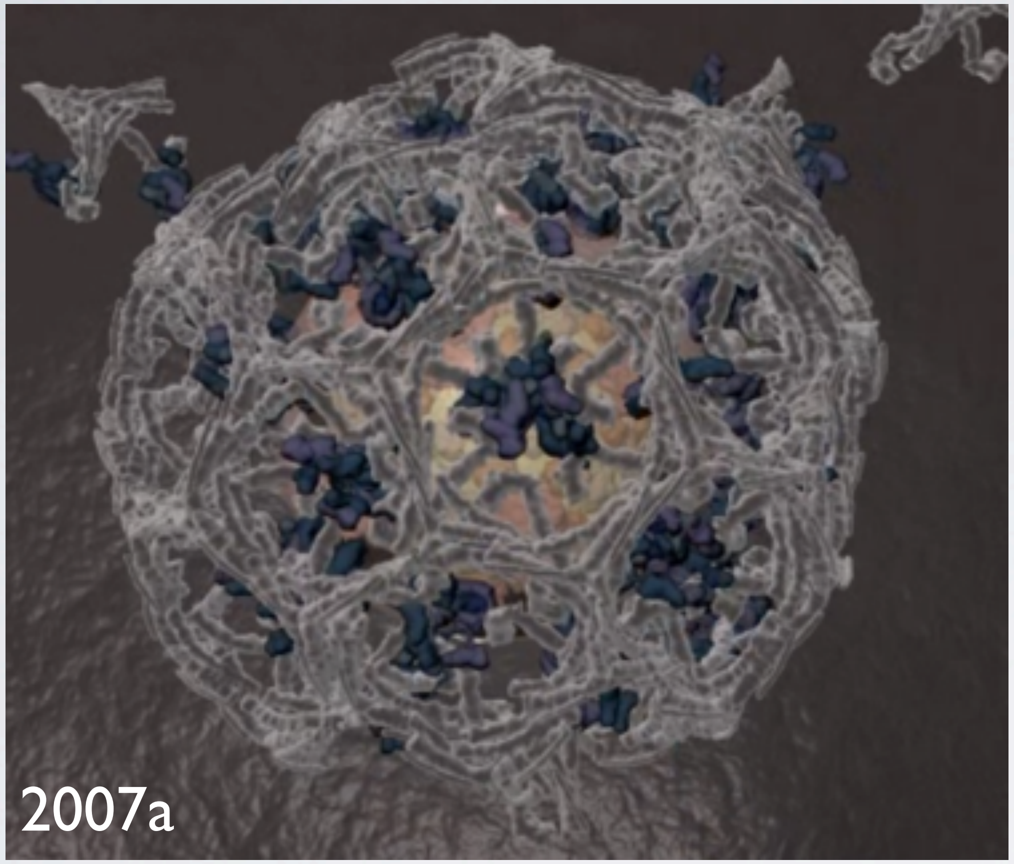


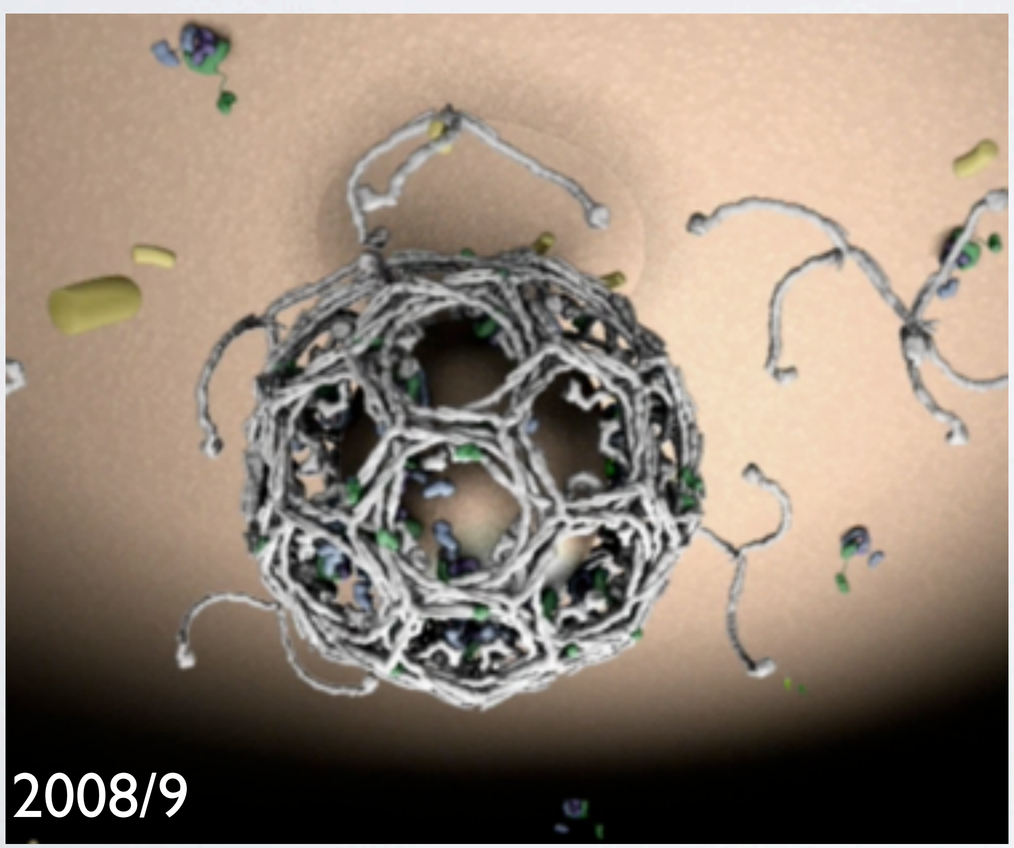
Thomas Splettstoesser / wikipedia



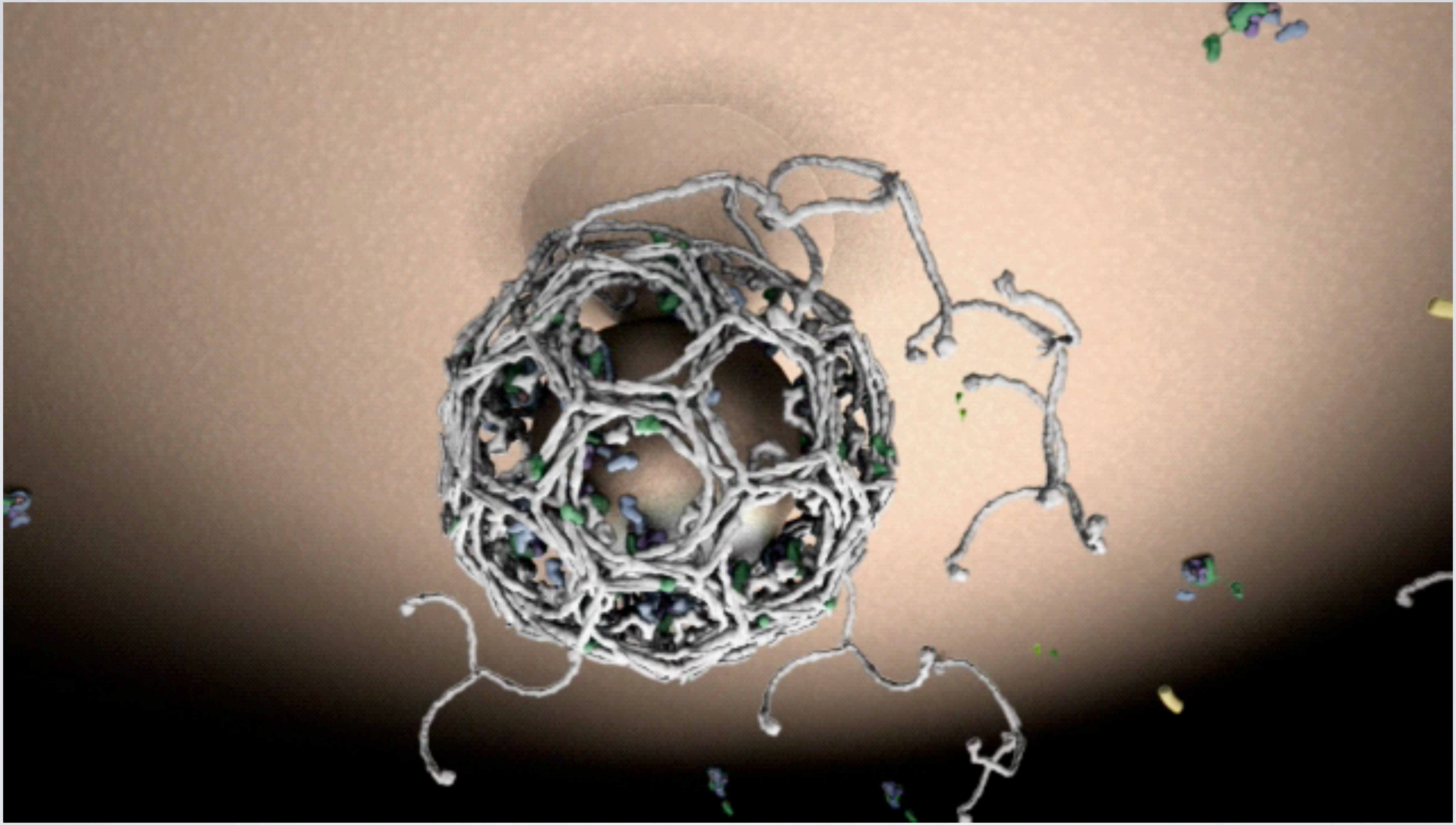
Eric Martz / U. Massachusetts

DRAFTS & REVISIONS

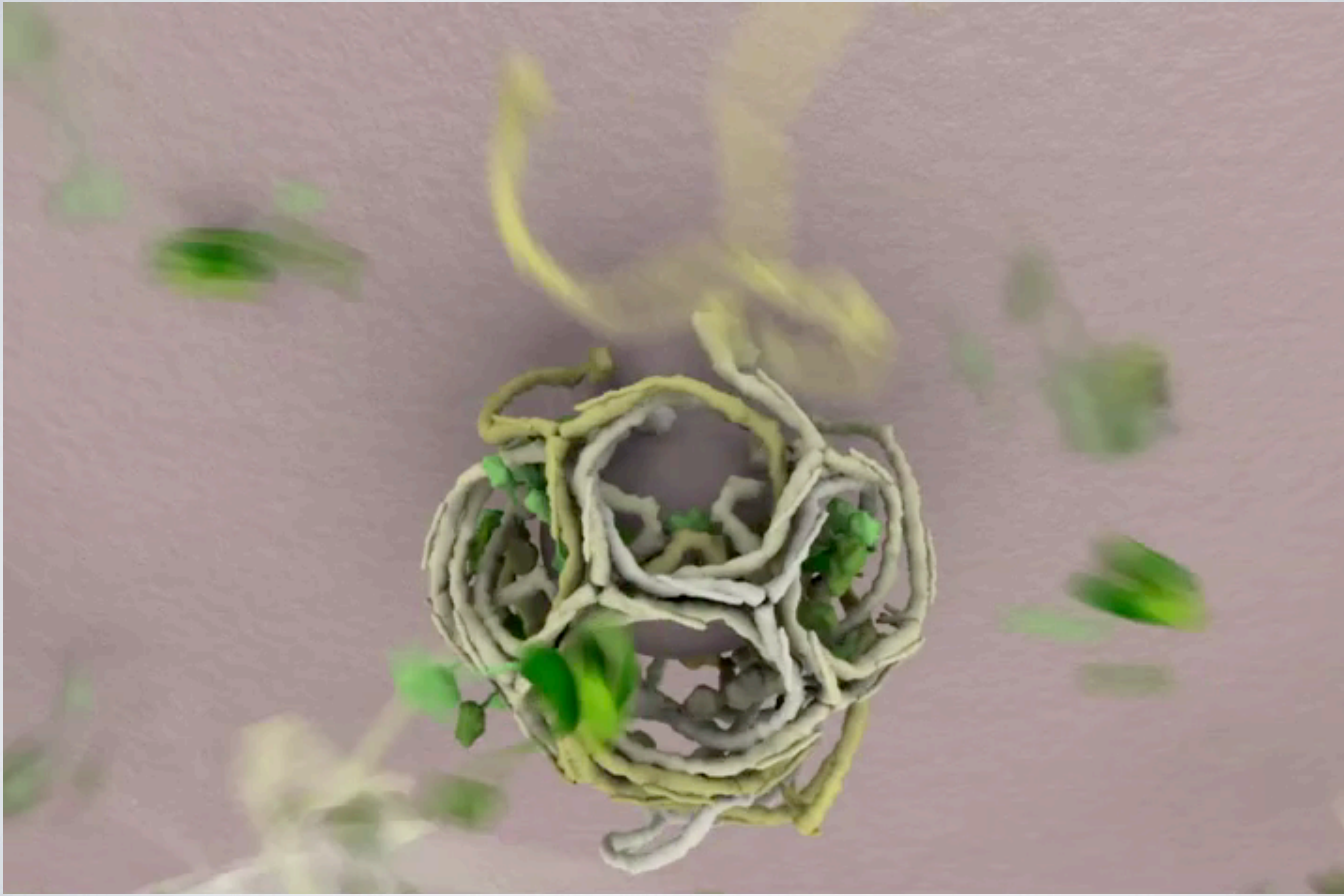




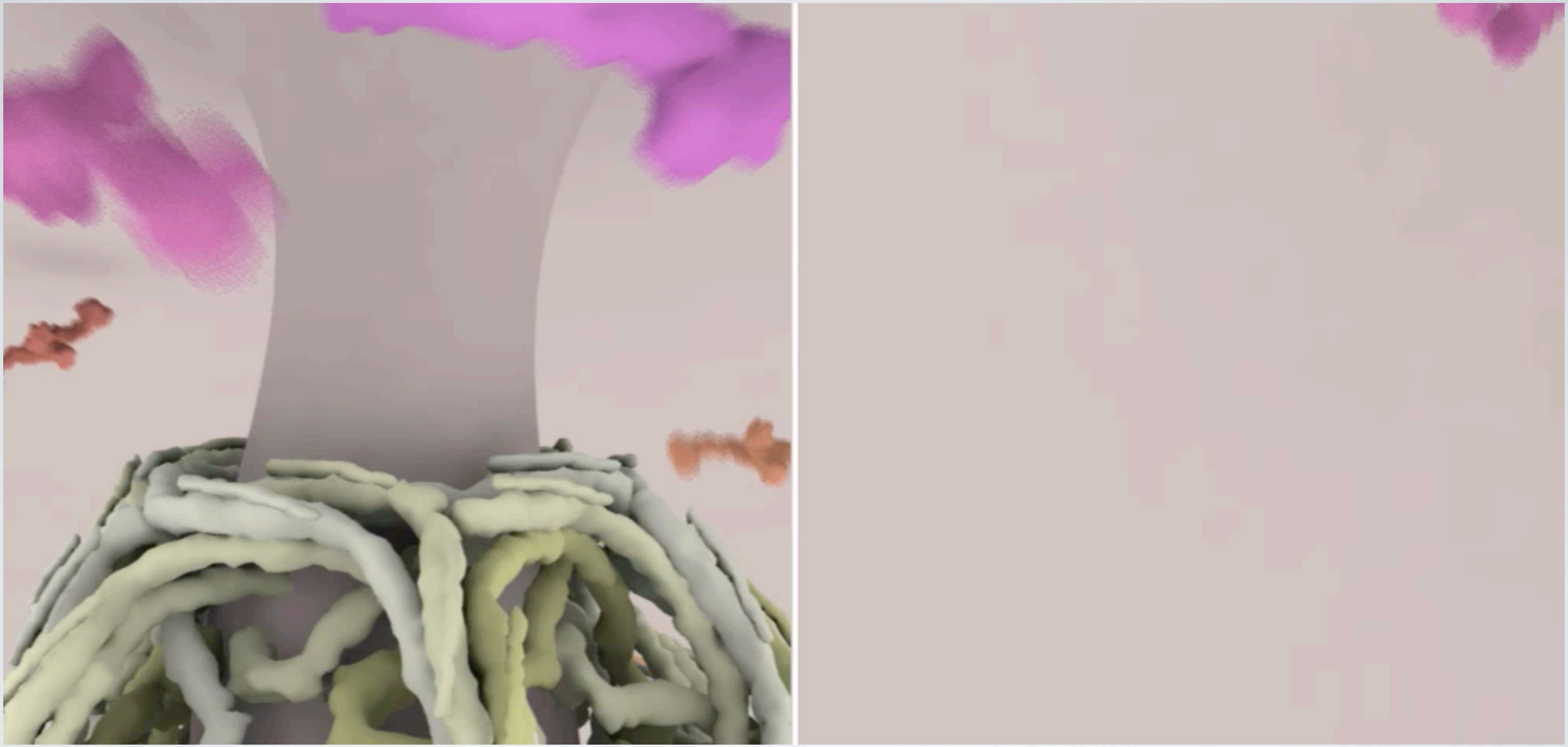
DYNAMIN - 2008

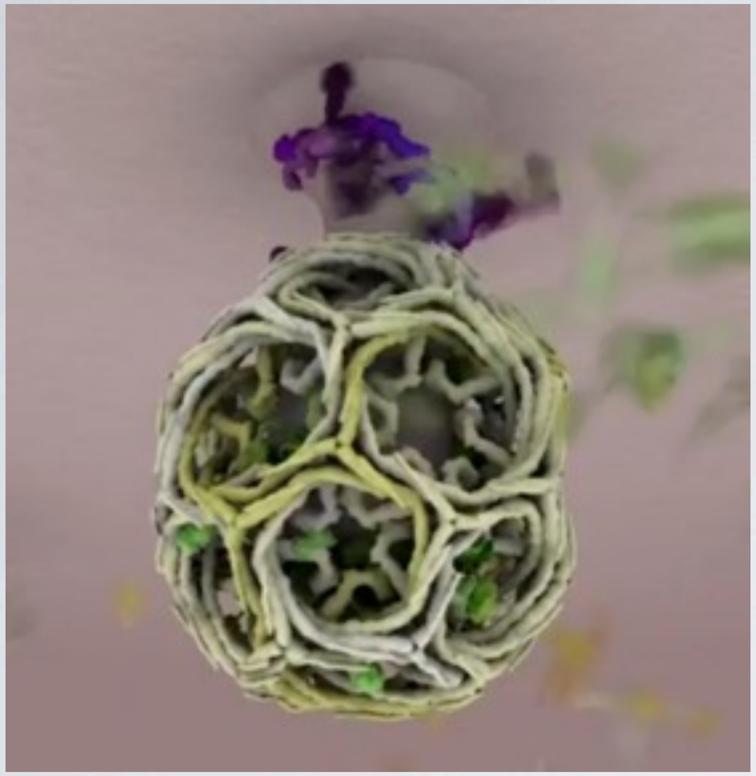
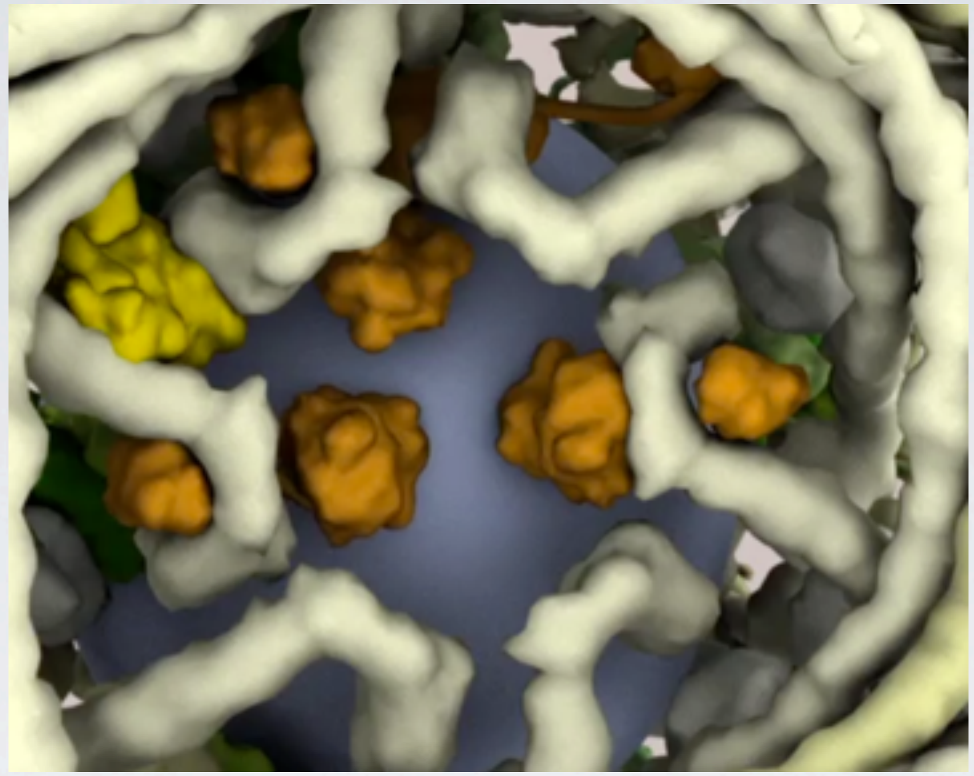
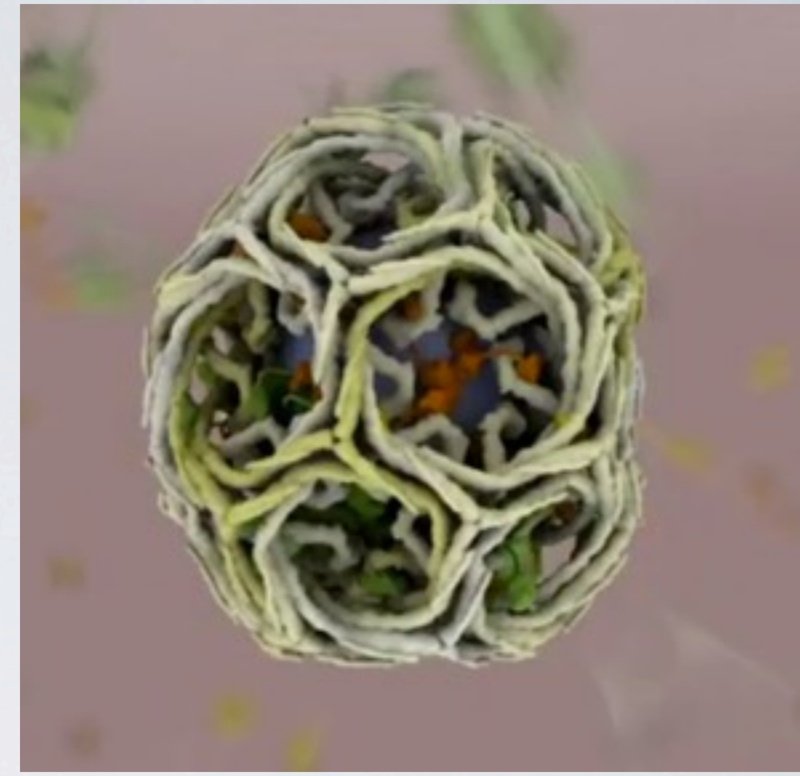


DYNAMIN - 2012



DYNAMIN - 2014



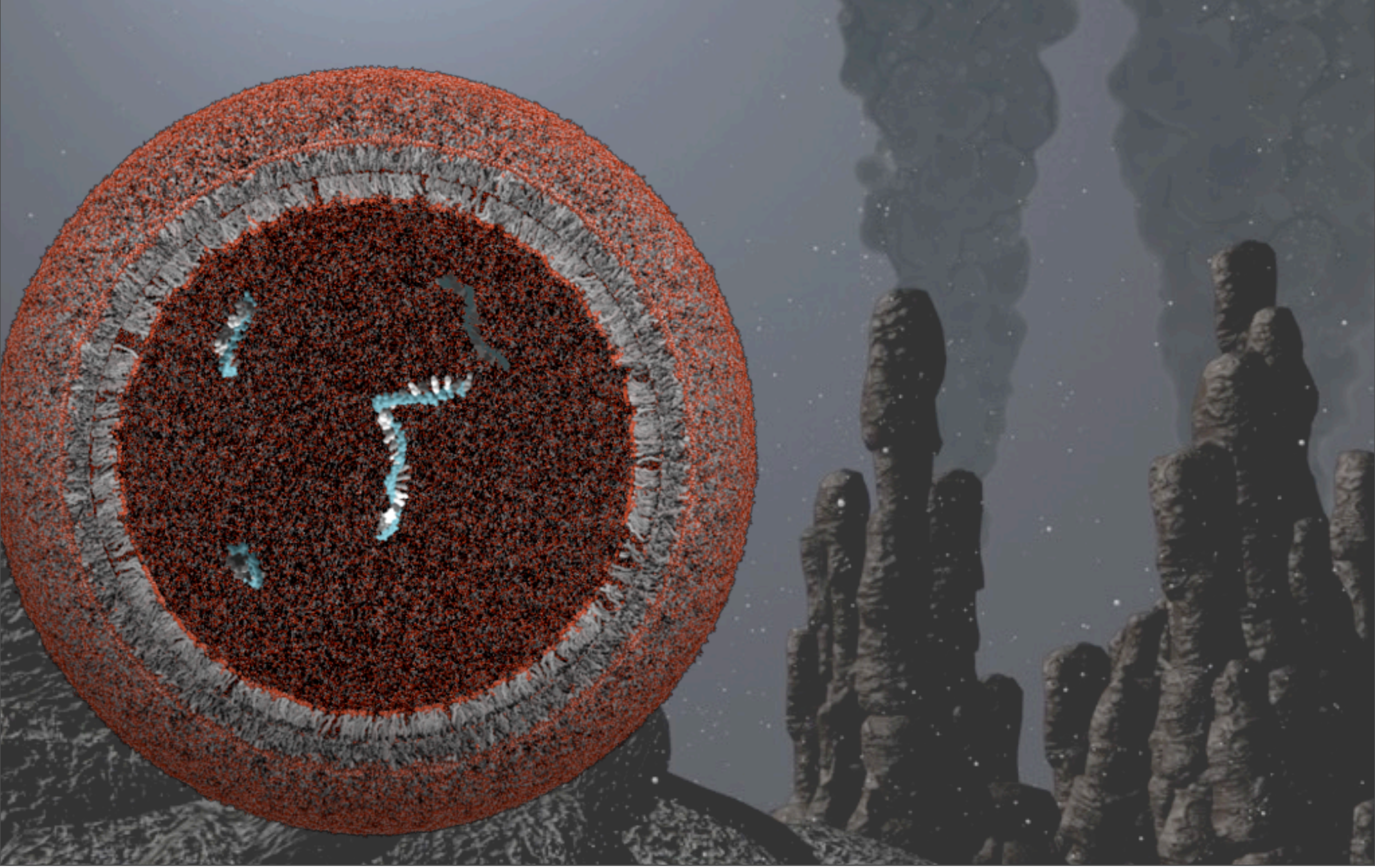




"Molecular 3D animations inform both the scientist who creates them and the audience that views them, through an active process leading to further inquiry and discovery."

- Tomas Kirchhausen, Harvard Medical School

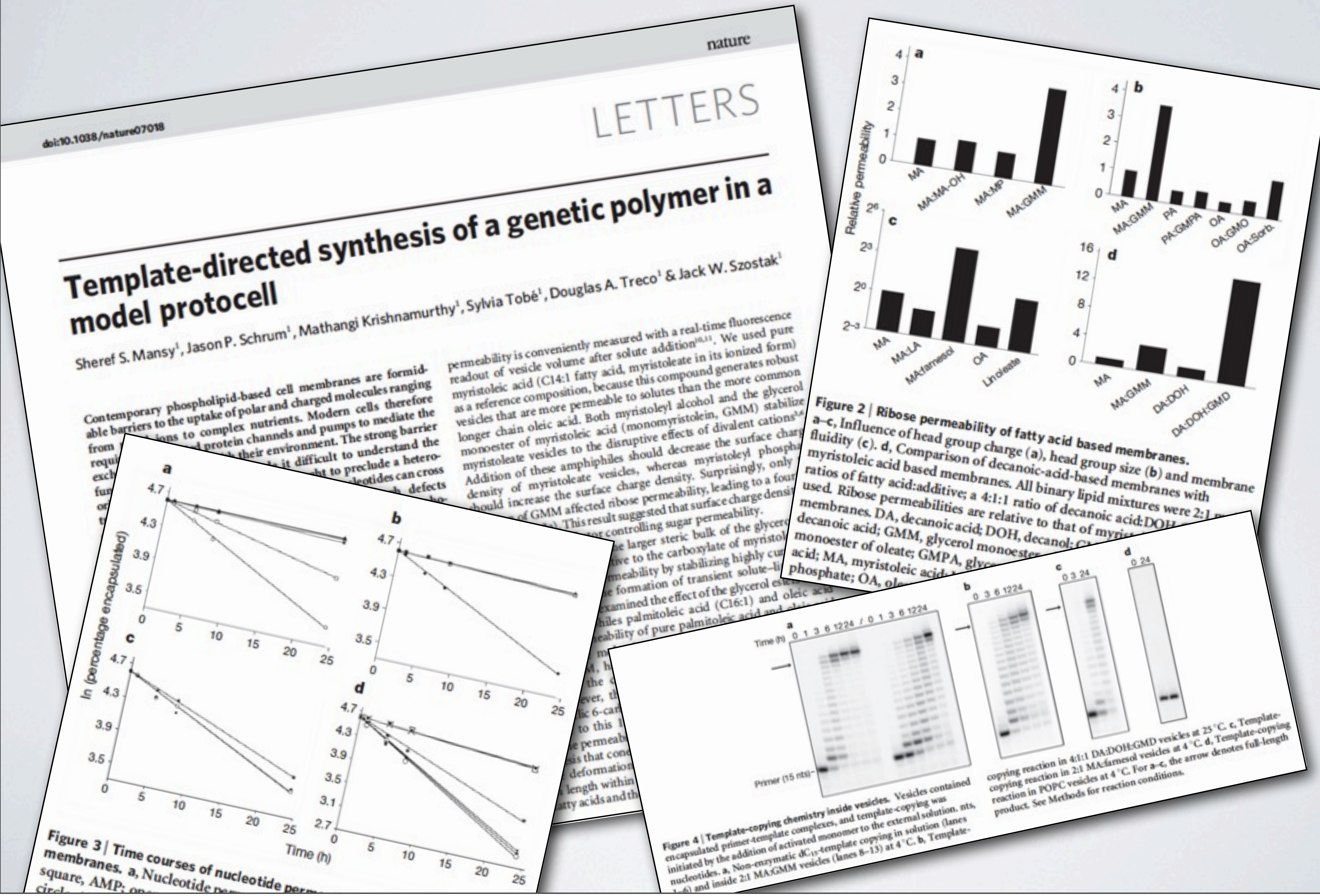
THE EXPLORING ORIGINS PROJECT

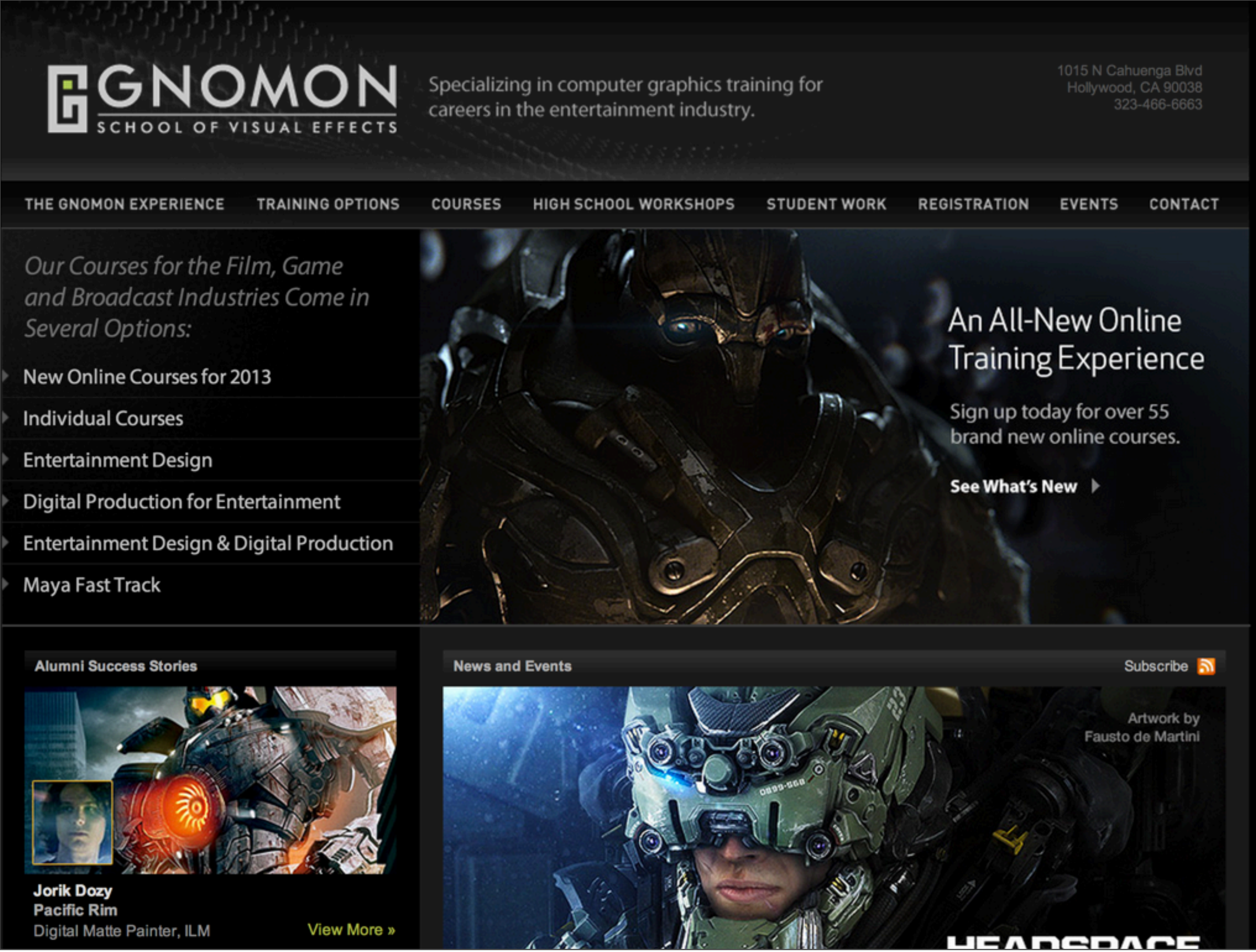
NSF Discovery Corps Postdoctoral Fellowship

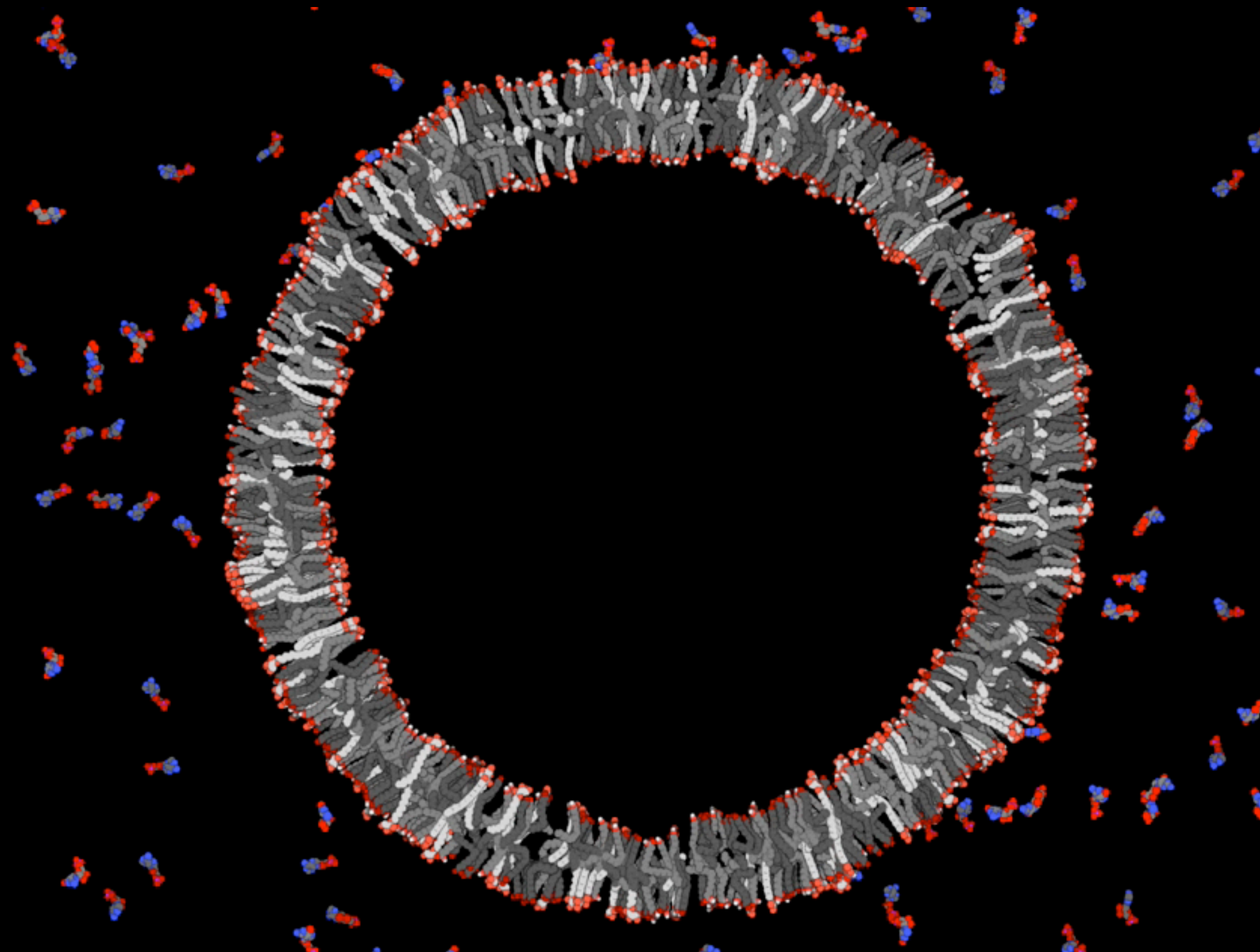


THE IMPORTANCE OF COMMUNICATION

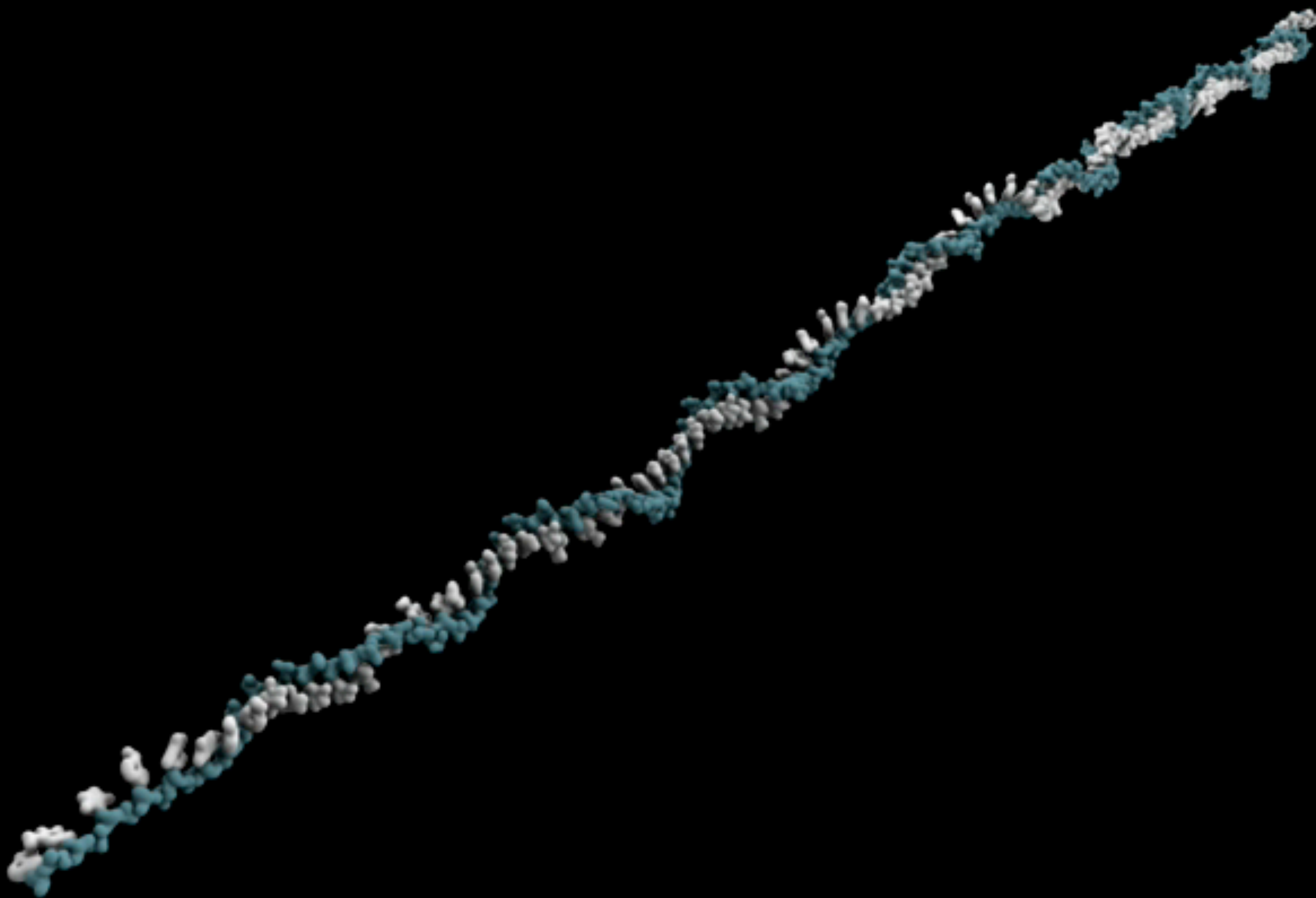
getting the public excited about your science




GNOMON
SCHOOL OF VISUAL EFFECTS
Specializing in computer graphics training for careers in the entertainment industry.
1015 N Cahuenga Blvd
Hollywood, CA 90038
323-466-6663
THE GNOMON EXPERIENCE
TRAINING OPTIONS
COURSES
HIGH SCHOOL WORKSHOPS
STUDENT WORK
REGISTRATION
EVENTS
CONTACT
Our Courses for the Film, Game and Broadcast Industries Come in Several Options:
New Online Courses for 2013
Individual Courses
Entertainment Design
Digital Production for Entertainment
Entertainment Design & Digital Production
Maya Fast Track
An All-New Online Training Experience
Sign up today for over 55 brand new online courses.
See What's New
Alumni Success Stories
Jorik Dozy
Pacific Rim
Digital Matte Painter, ILM
View More »
News and Events
Subscribe
Artwork by
Fausto de Martini

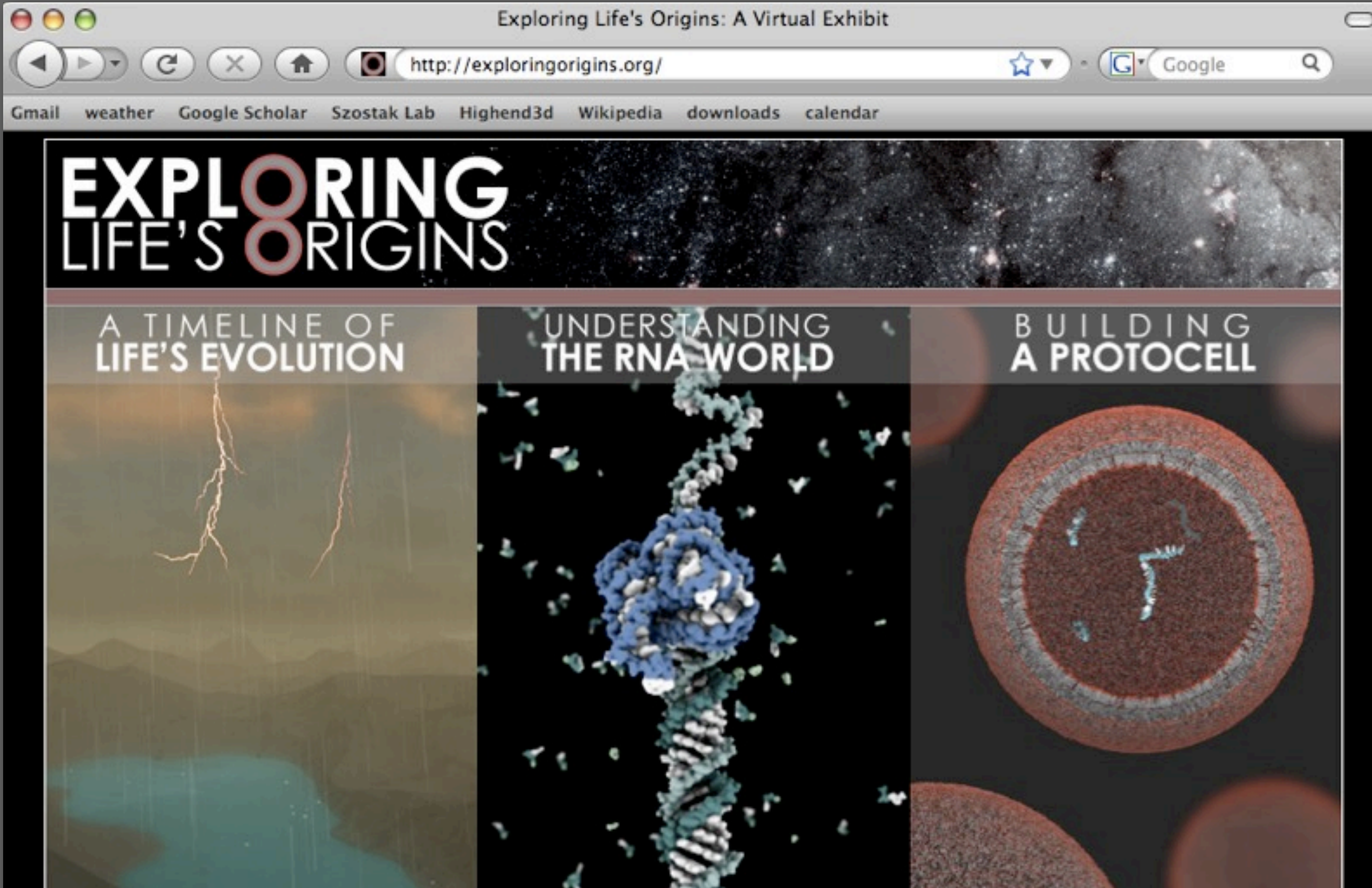


Entry of Small Molecules into Vesicles
with Jack Szostak | Harvard Medical School



A simplified depiction of RNA folding
with Jack Szostak | Harvard Medical School

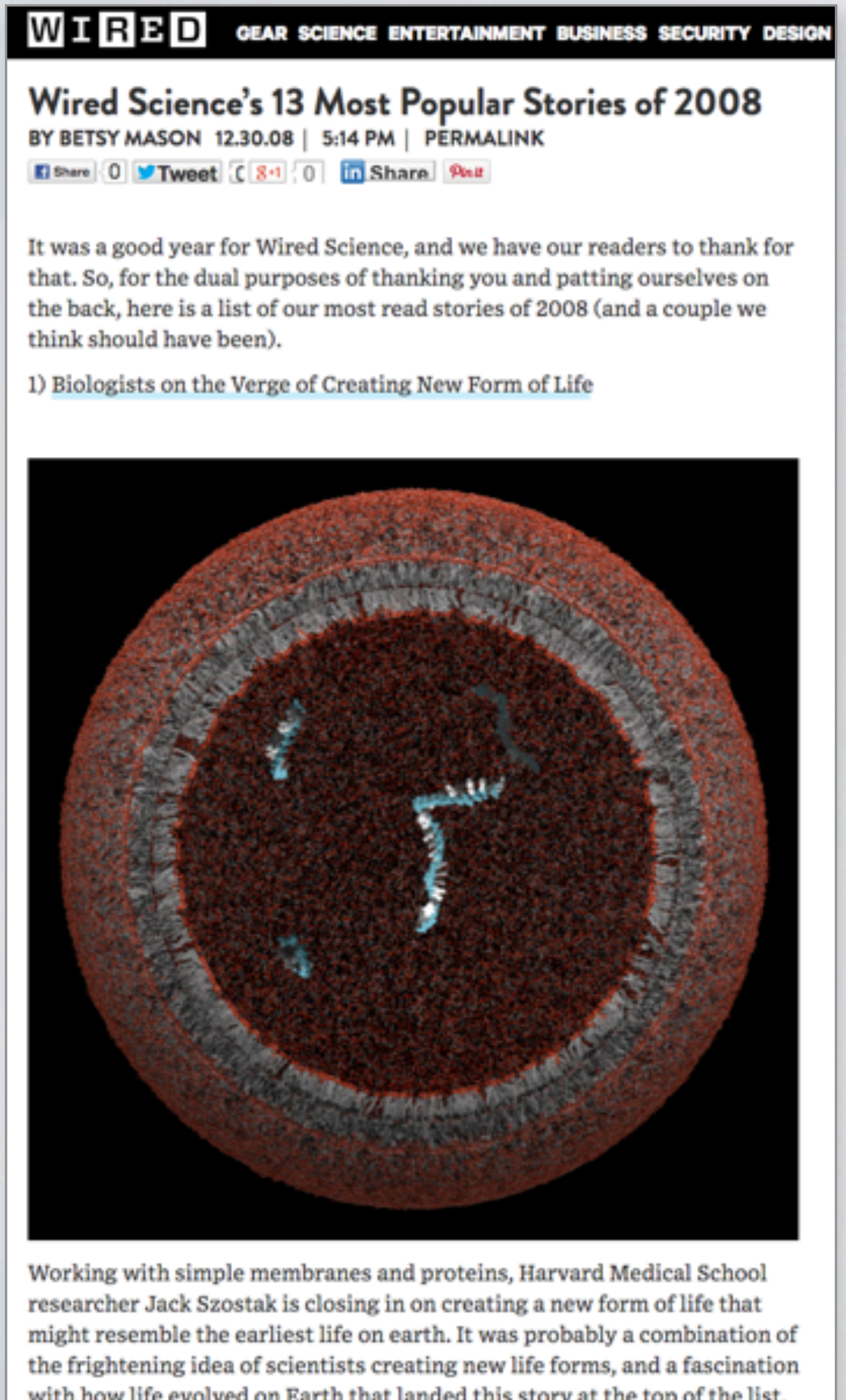
Exploring Origins: Exhibit
Museum of Science, Boston 2008-2013



Exploring Origins: A Virtual Exhibit
with Jack Szostak | Harvard Medical School

THE IMPORTANCE OF VISUALIZATION

getting the public excited about your science



WIRED GEAR SCIENCE ENTERTAINMENT BUSINESS SECURITY DESIGN

Wired Science's 13 Most Popular Stories of 2008

BY BETSY MASON 12.30.08 | 5:14 PM | PERMALINK

Share 0 Tweet 0 g+1 0 in Share Pin it

It was a good year for Wired Science, and we have our readers to thank for that. So, for the dual purposes of thanking you and patting ourselves on the back, here is a list of our most read stories of 2008 (and a couple we think should have been).

1) Biologists on the Verge of Creating New Form of Life

Working with simple membranes and proteins, Harvard Medical School researcher Jack Szostak is closing in on creating a new form of life that might resemble the earliest life on earth. It was probably a combination of the frightening idea of scientists creating new life forms, and a fascination with how life evolved on Earth that landed this story at the top of the list.

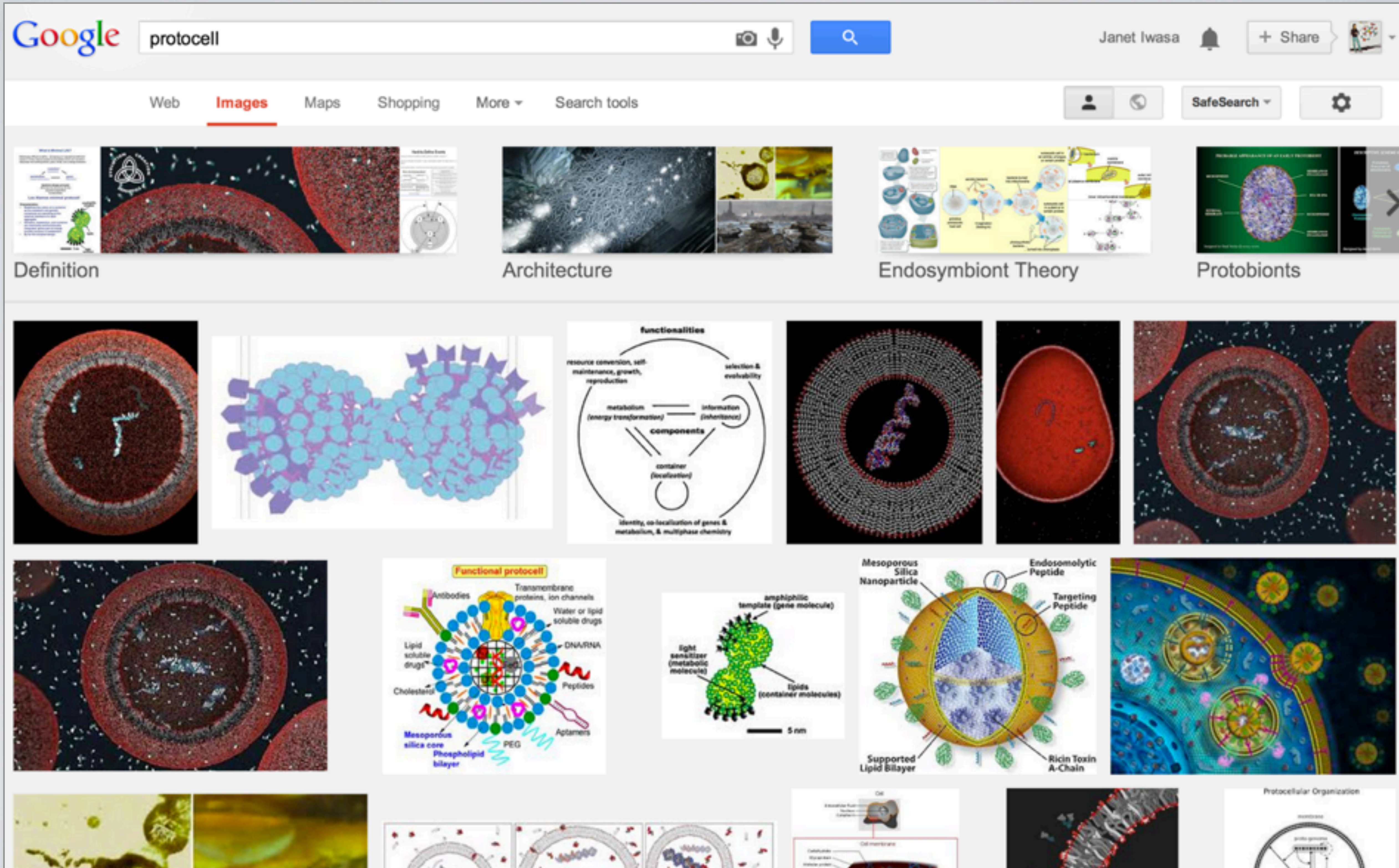
Science Times

The New York Times

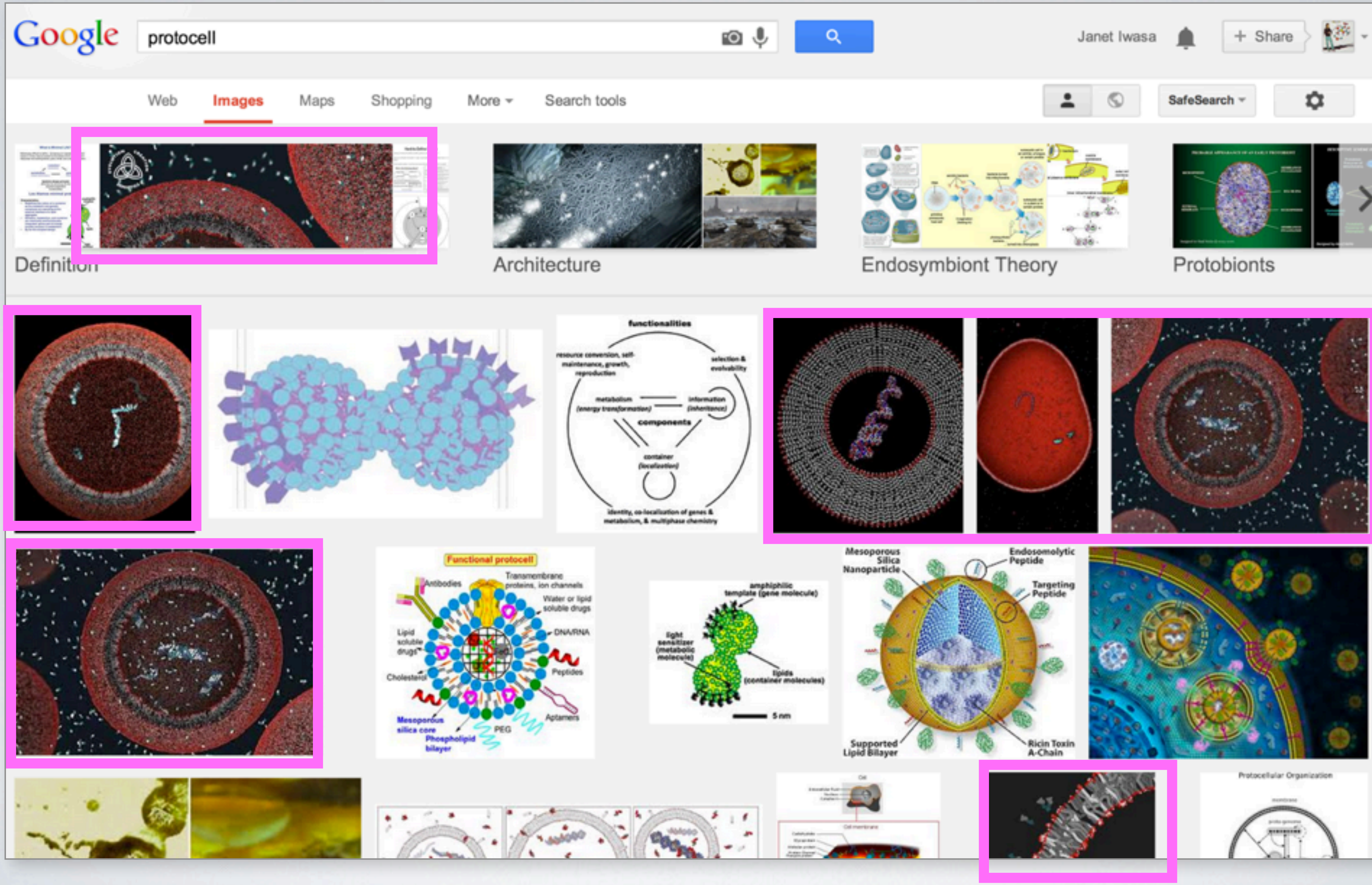
New Glimpses of Life's Puzzling Origins

Researchers find new ways for biochemicals to self-assemble.

MAKING RESEARCH ACCESSIBLE

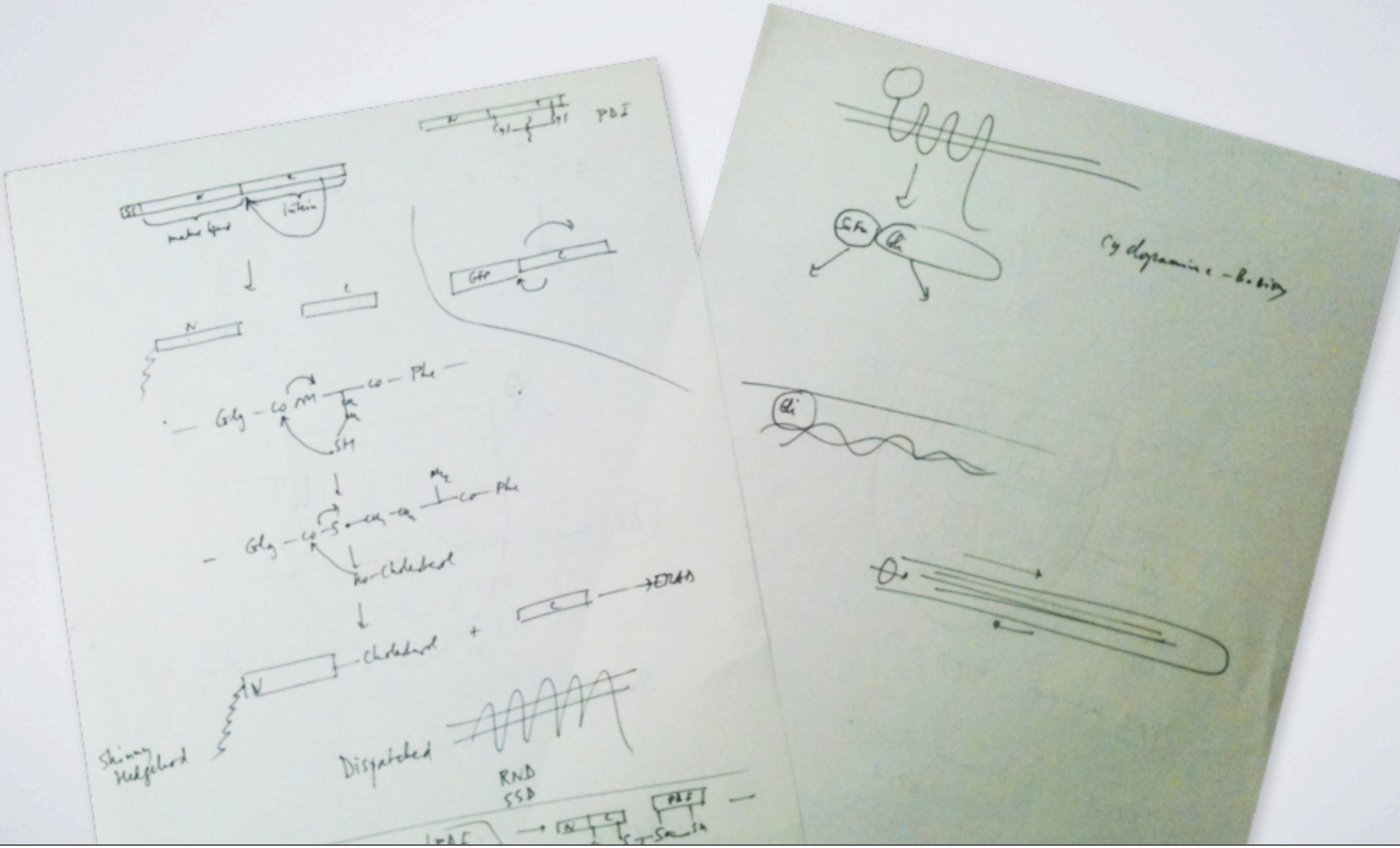


MAKING RESEARCH ACCESSIBLE



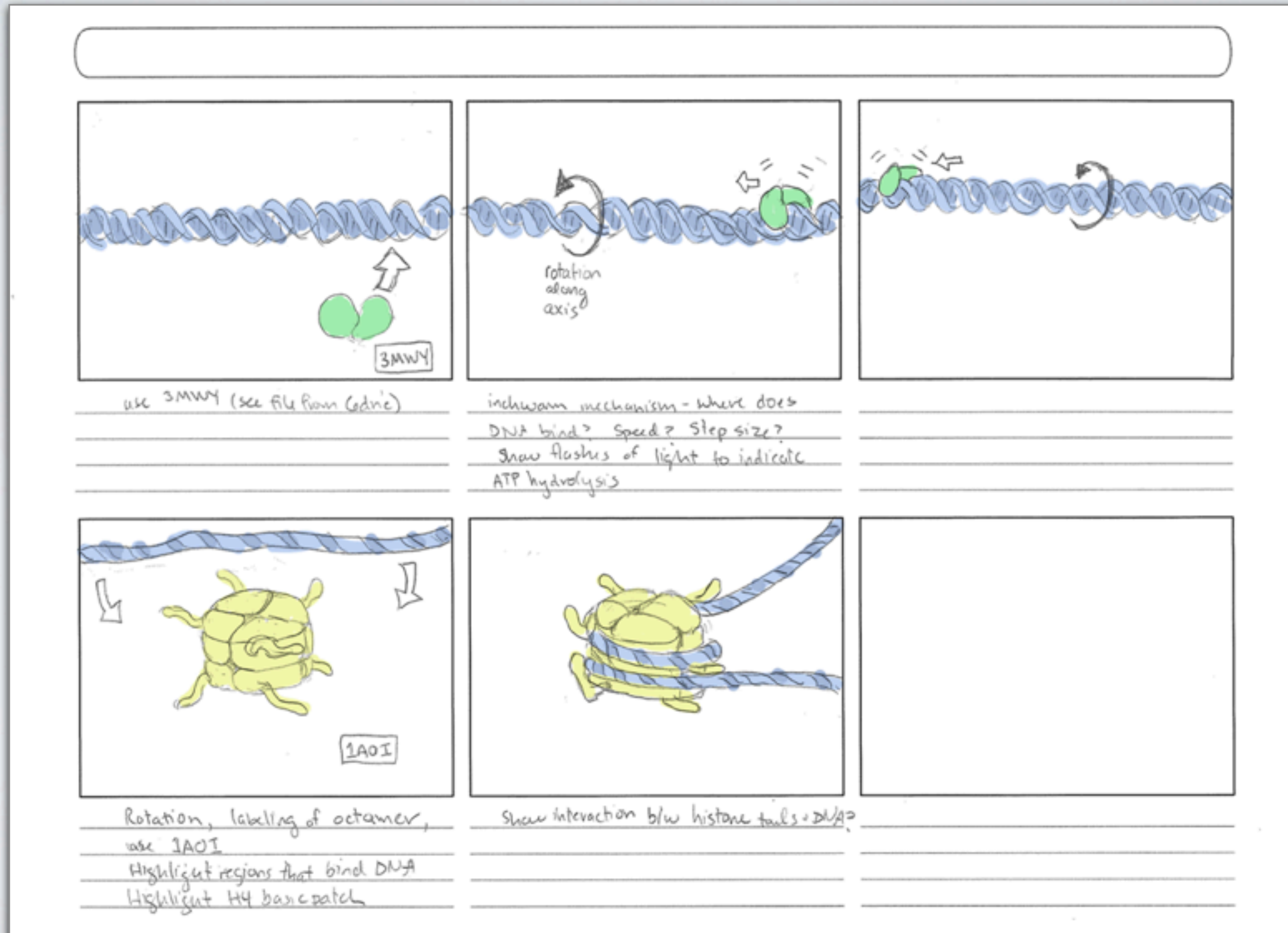
THE MAKING OF AN ANIMATION

1. What is the story?



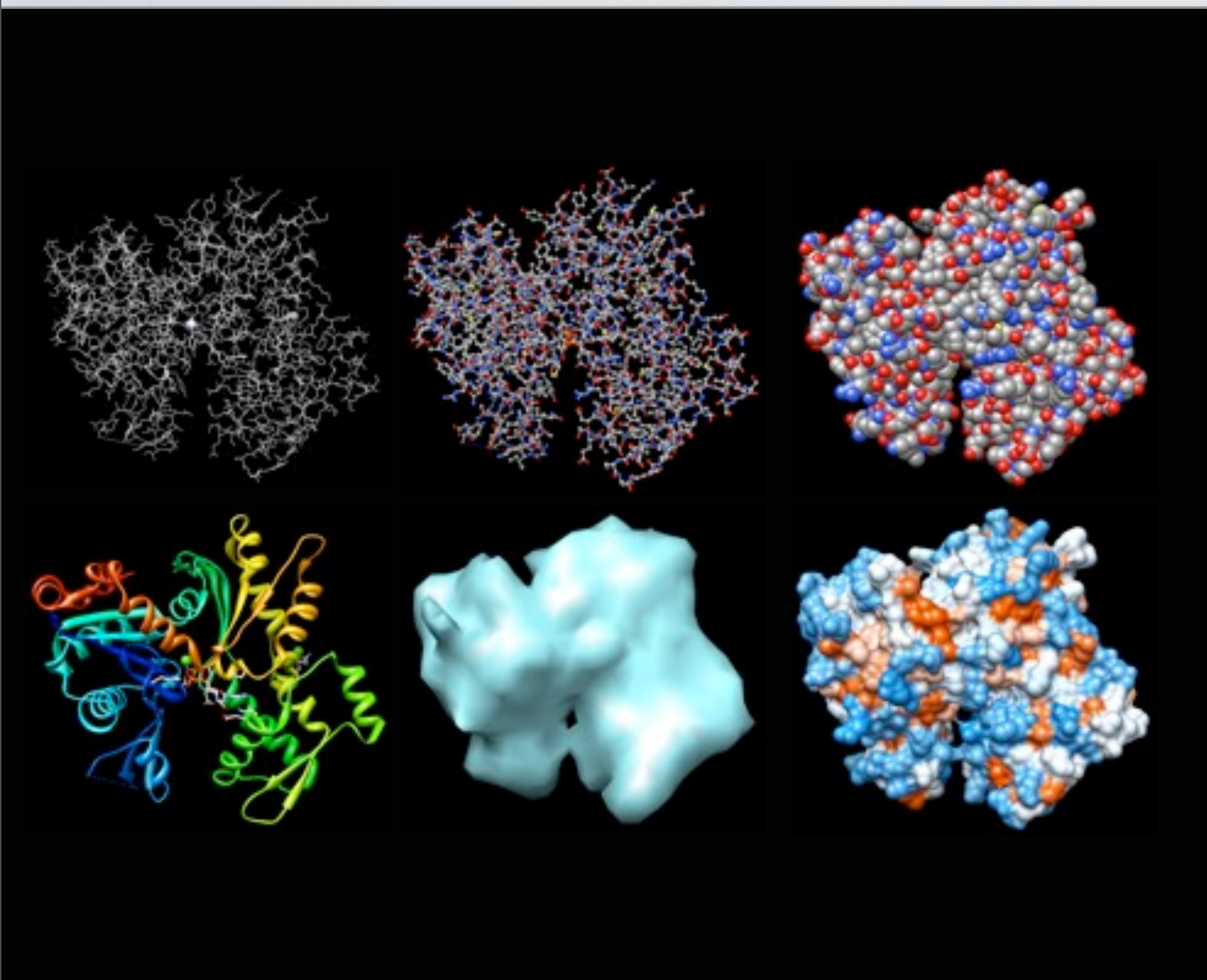
THE MAKING OF AN ANIMATION

2. Drawing a storyboard



THE MAKING OF AN ANIMATION

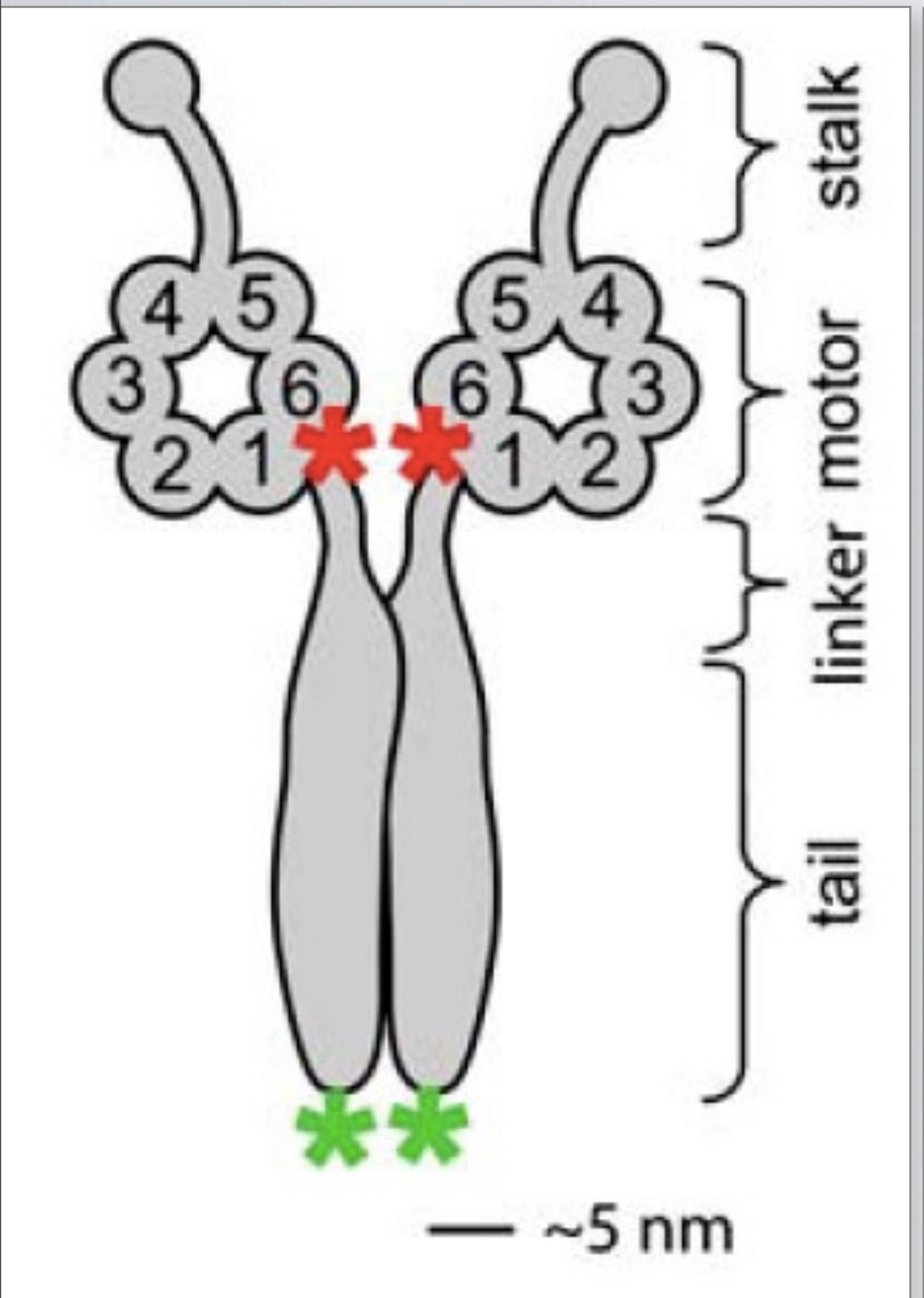
3. Modeling proteins and other structures

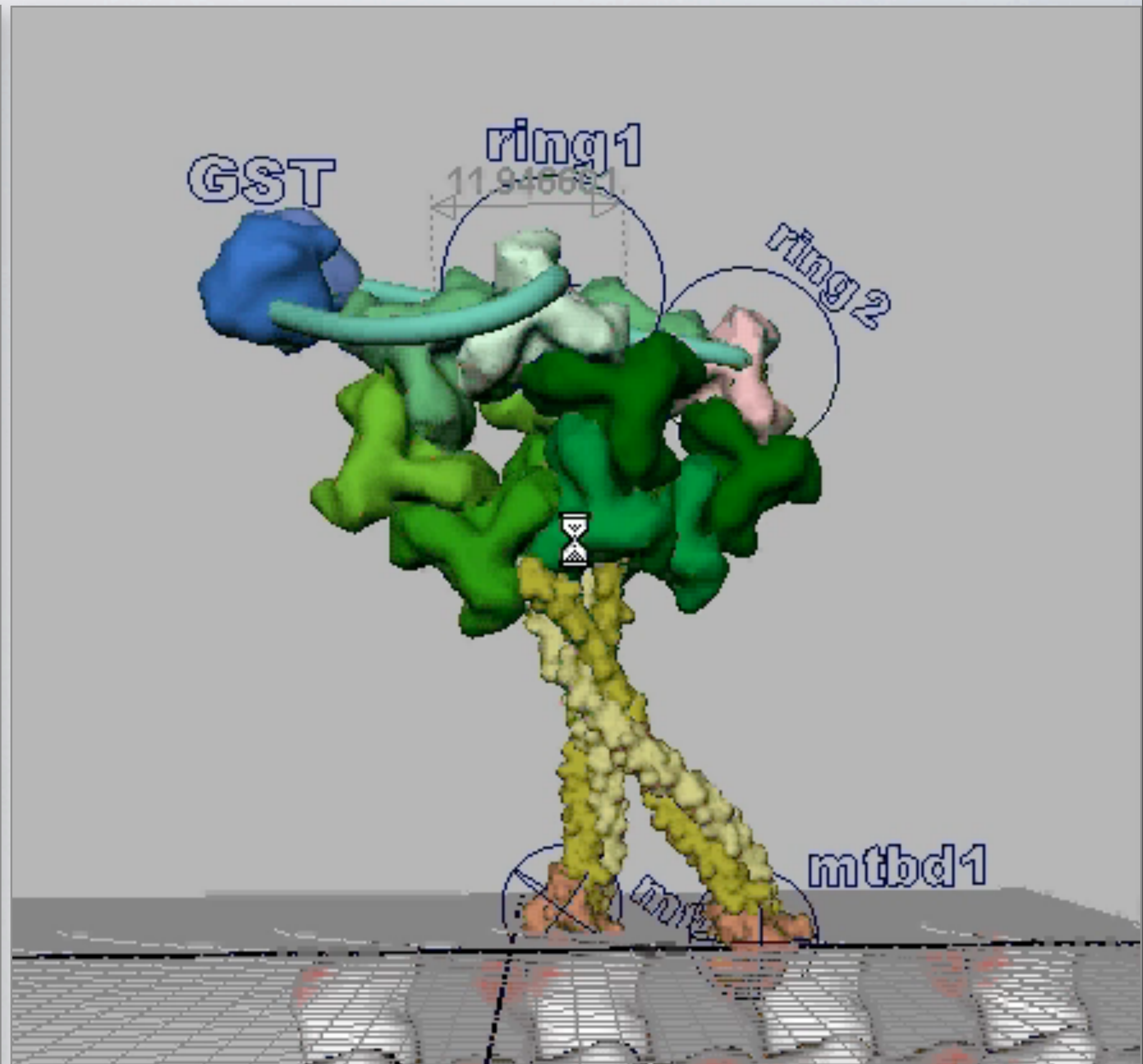


with Wendell Lim and Brian Yeh, *Nature Chemical Biology* 3 (2007)

THE MAKING OF AN ANIMATION

an articulated model of dynein





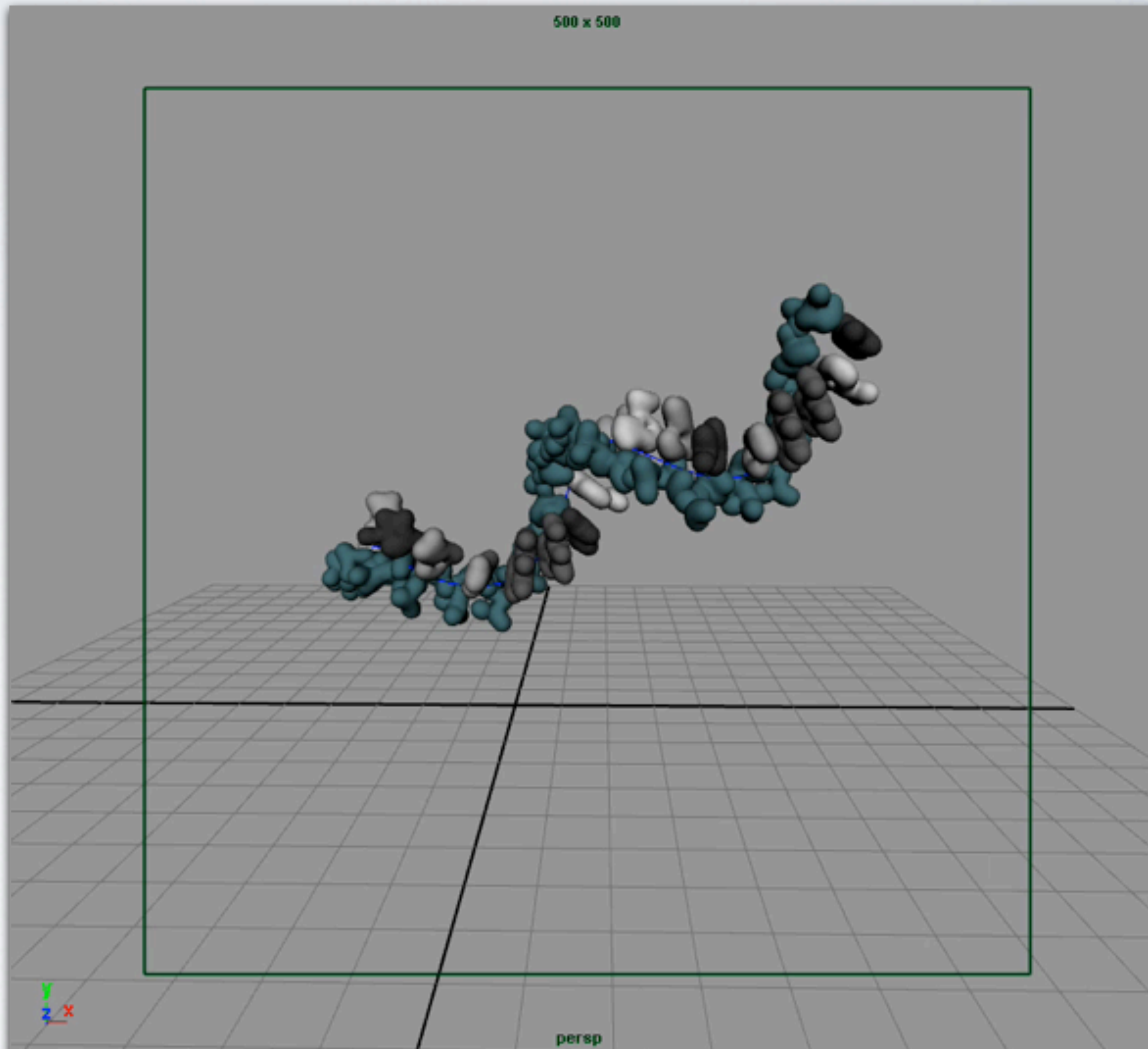
with Sam Reck-Peterson, Harvard Medical School

THE MAKING OF AN ANIMATION

4. Animation

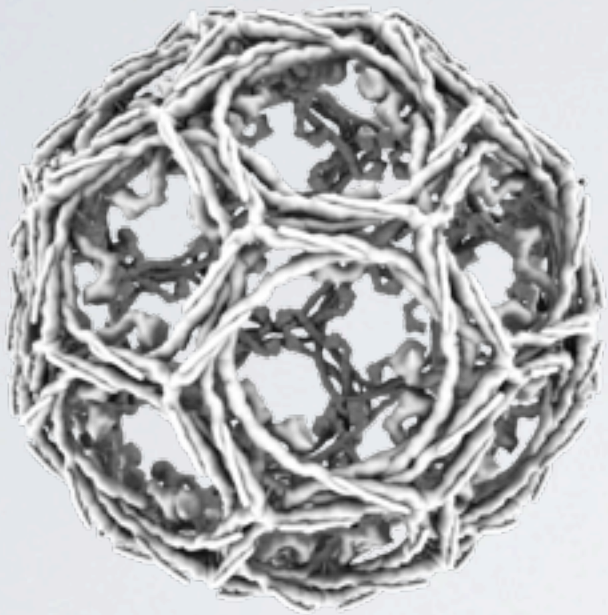
What tools are available?

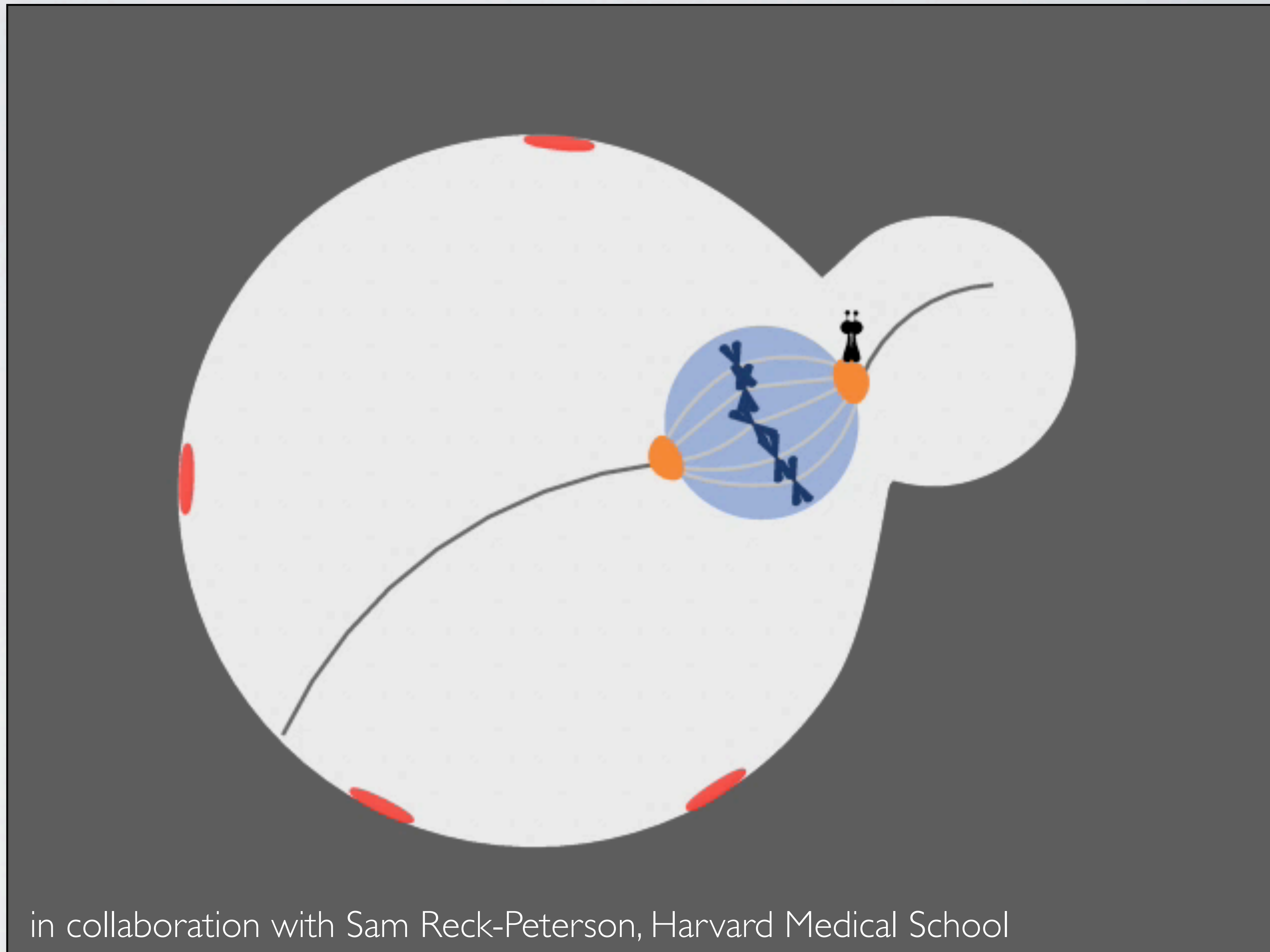
How to create animations that can depict expected molecular motions?



THE MAKING OF AN ANIMATION

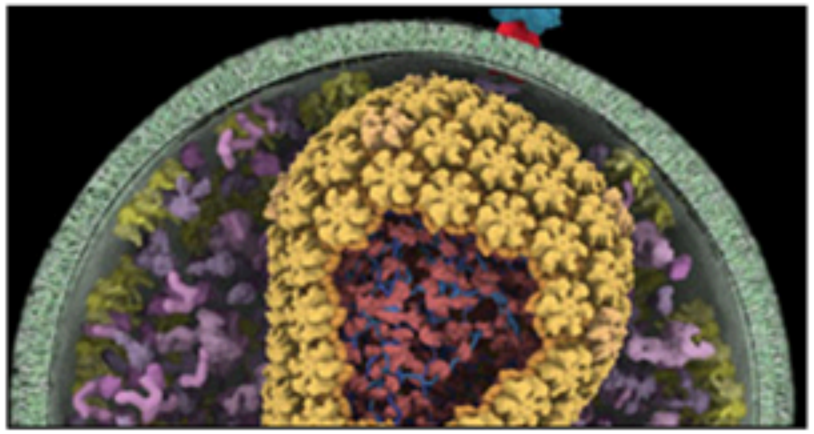
5. Rendering



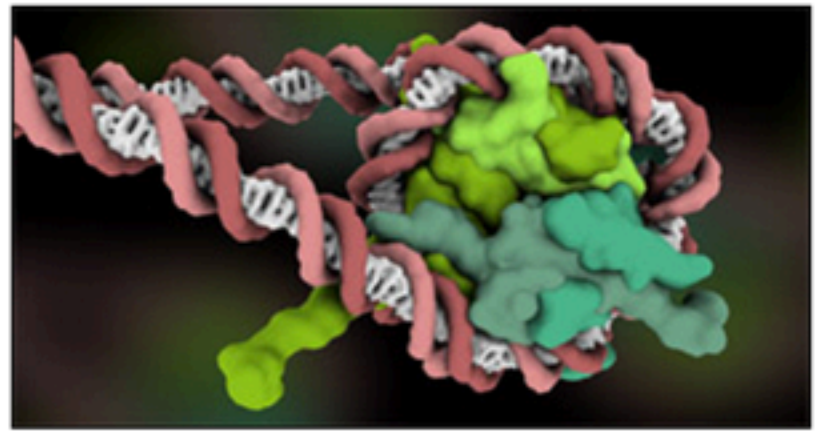


in collaboration with Sam Reck-Peterson, Harvard Medical School

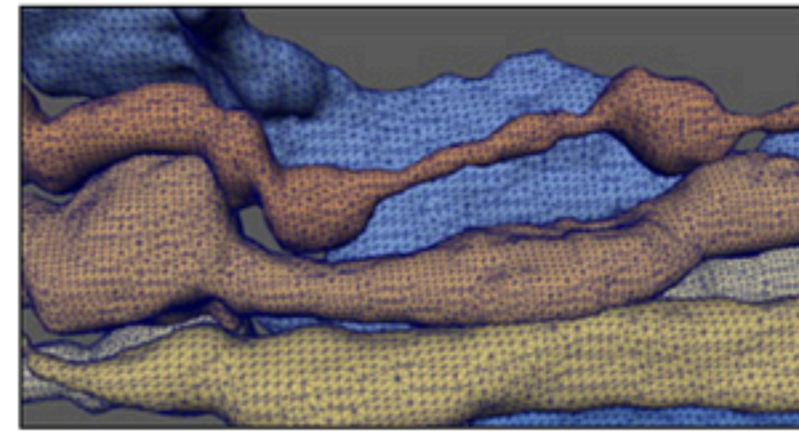
CURRENT PROJECTS



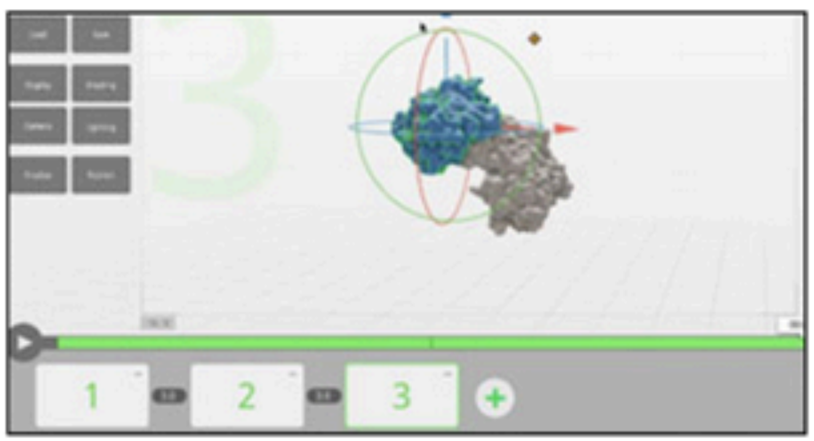
HIV entry and egress



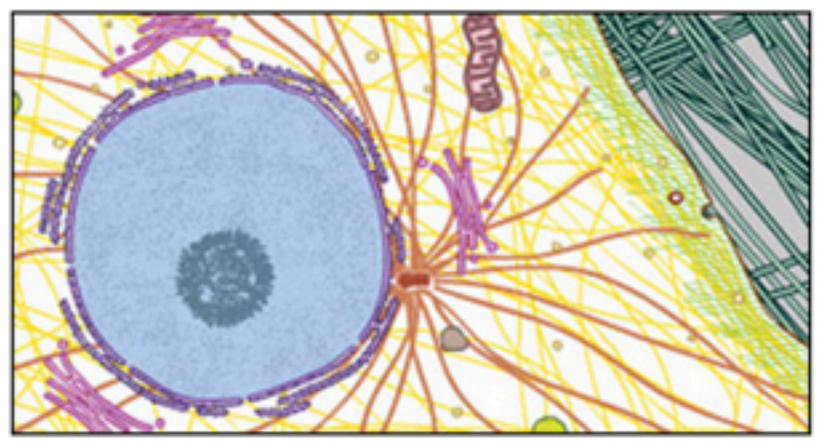
Chromatin remodeling



Visualizing neurons



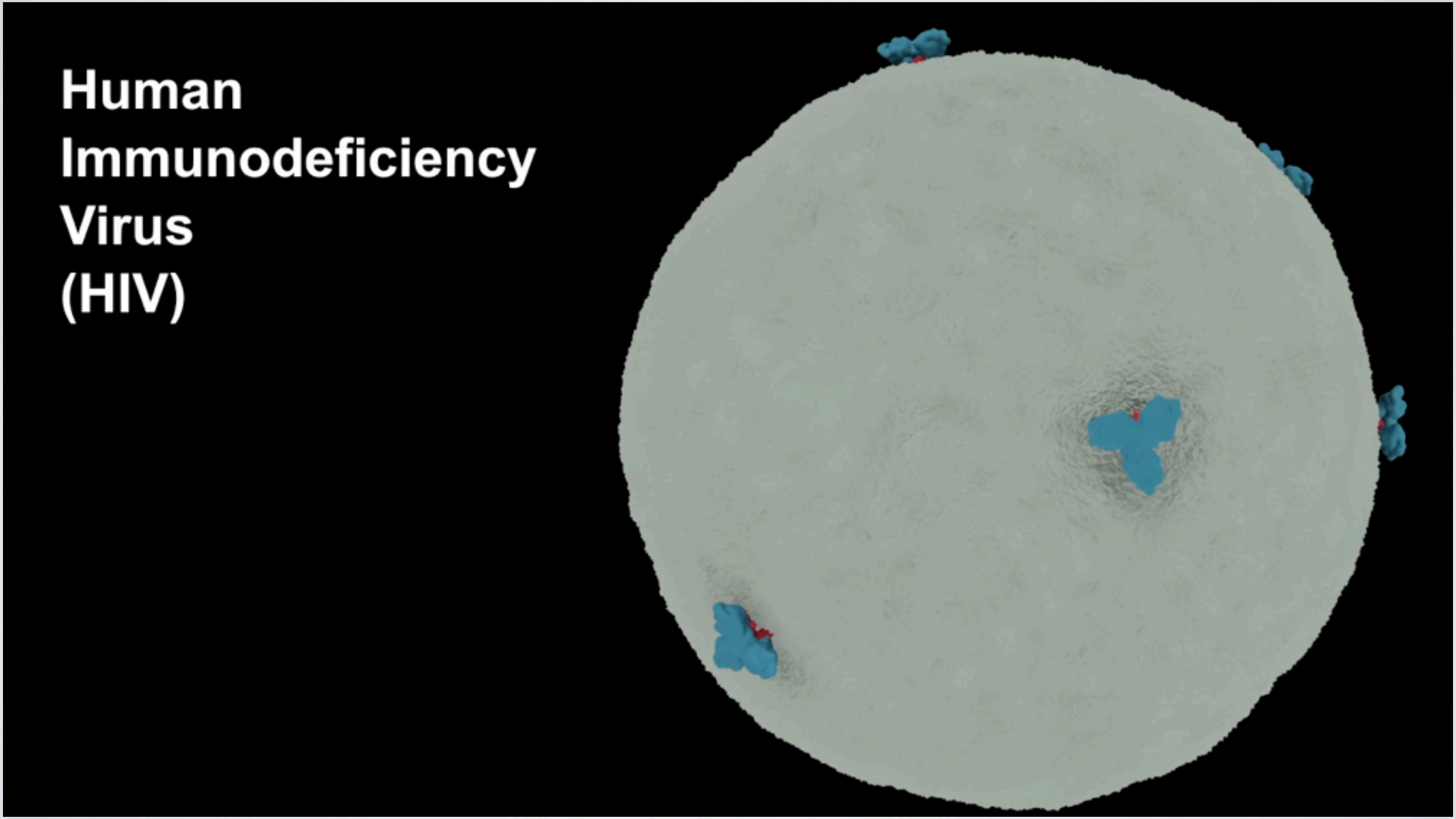
Molecular flipbook



Cell image library

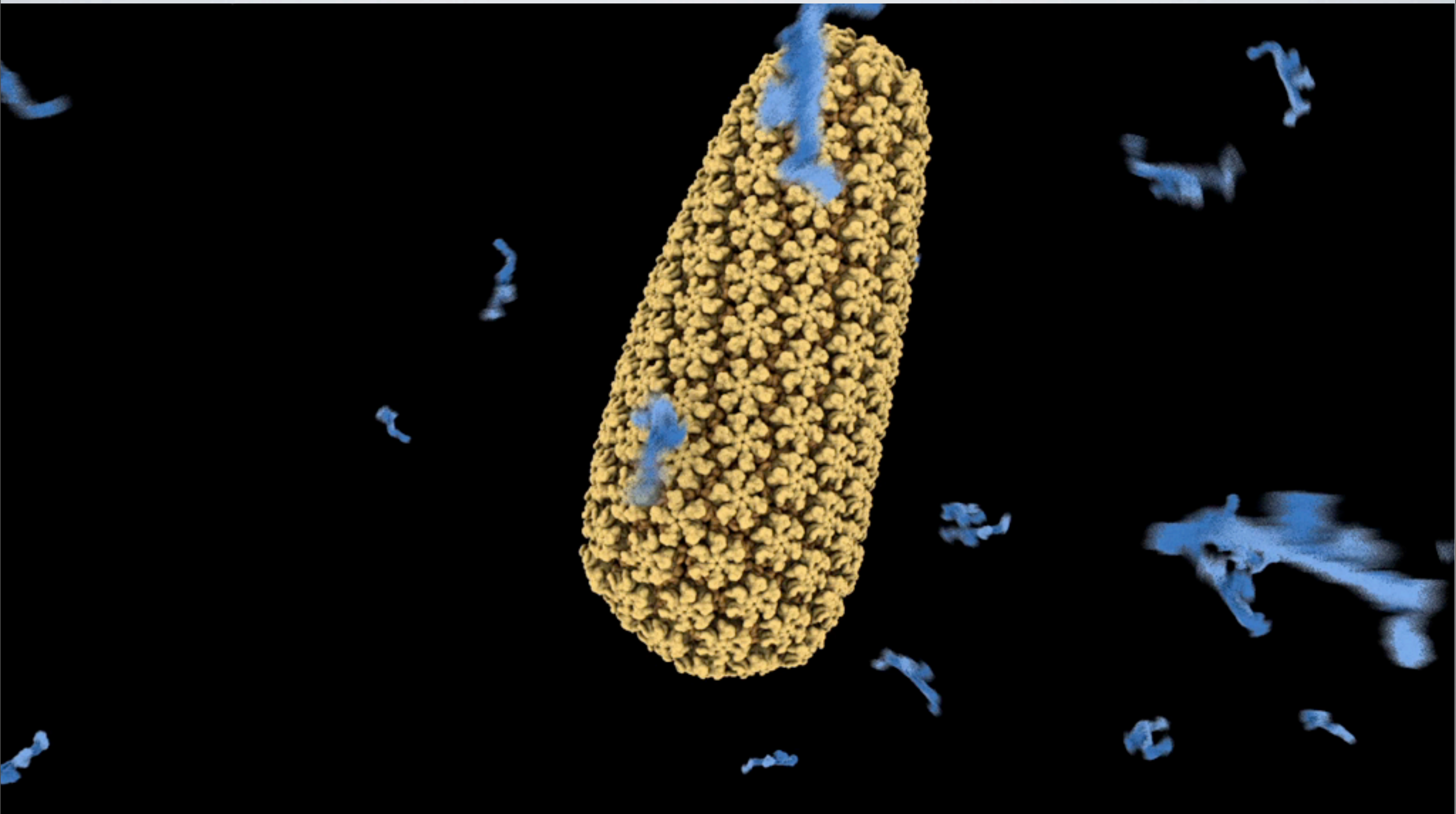
ANIMATING THE HIV LIFE CYCLE

with NIGMS (P50) Centers for HIV/AIDS Related Structural Biology

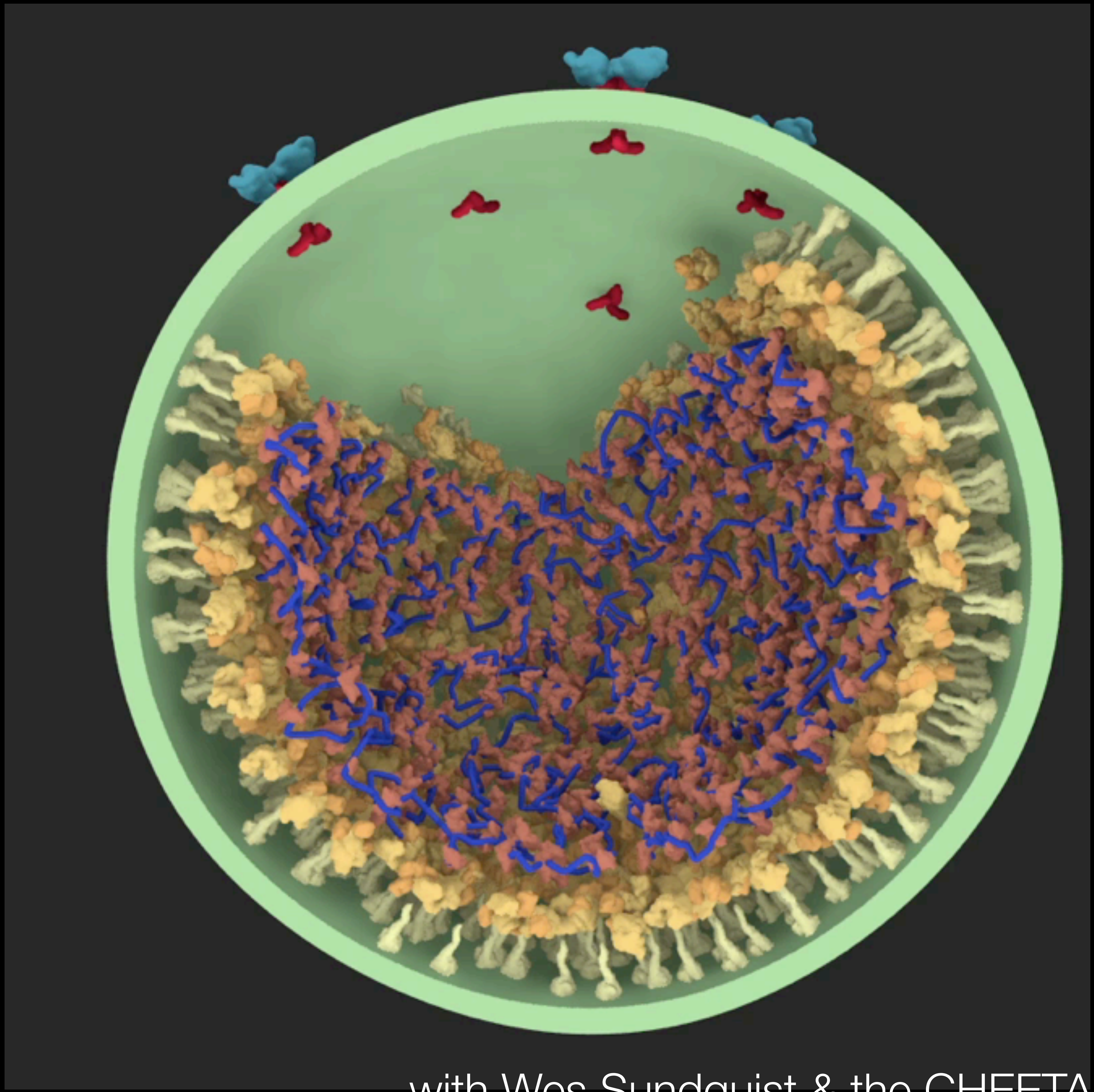


HIV ENTRY

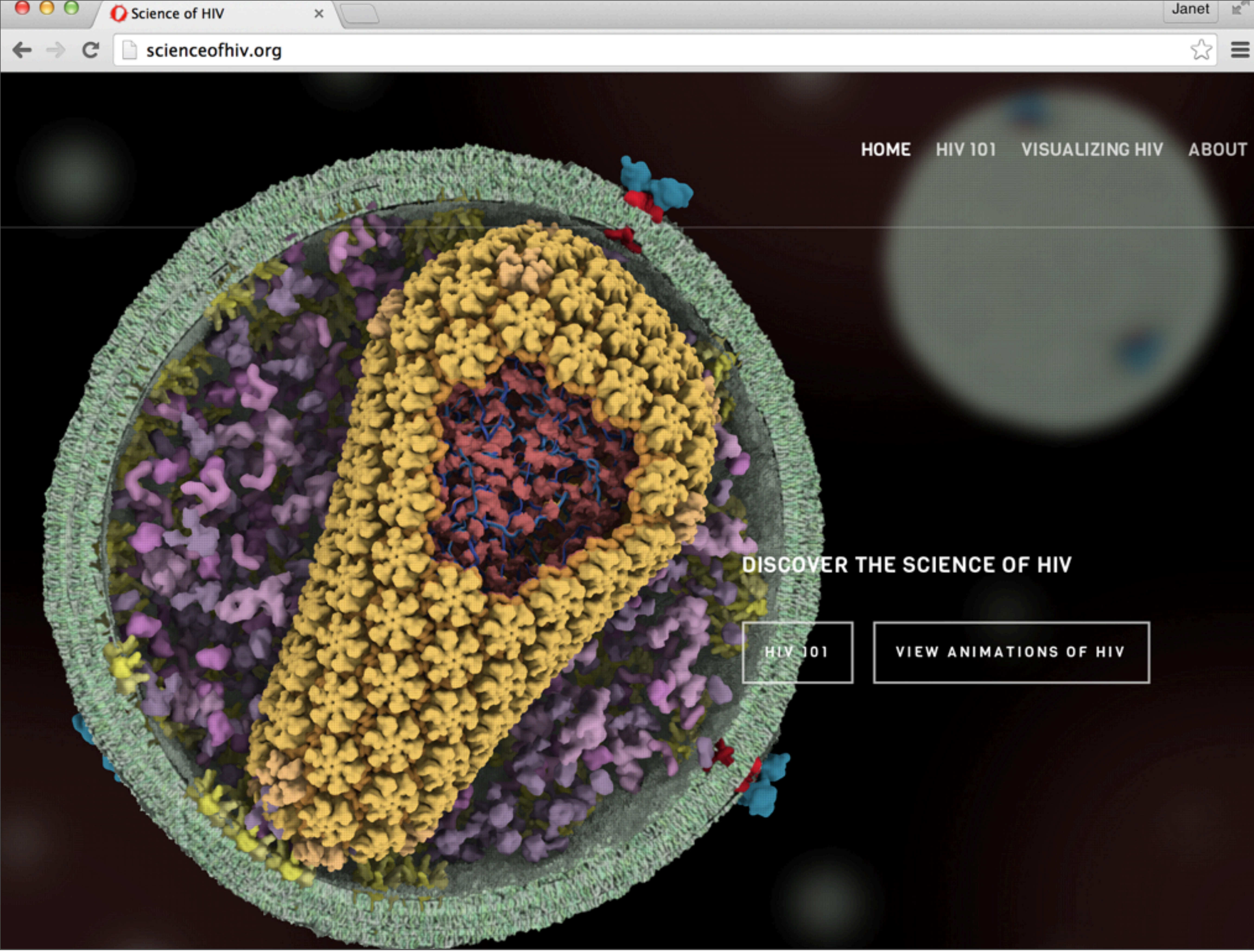
TRIM5α LATTICE FORMATION



HIV MATURATION



with Wes Sundquist & the CHEETAH consortium



Monday, November 9, 15

Build a lesson around any TED-Ed Original, TED Talk or YouTube video

Create a Lesson

Why it's so hard to cure HIV/AIDS - Janet Iwasa

TED-Ed Original

52,903 Views

458 Questions Answered

Let's Begin…

In 2008, something incredible happened: a man was cured of HIV. In over 70 million HIV cases, this was a first, and, so far, a last, and we don't yet understand exactly how he was cured. But if we ca cure people of various diseases, like malaria and hepatitis C, why can't we cure HIV? Janet Iwasa examines the specific traits of the HIV virus that make it so difficult to cure.

Watch

Think

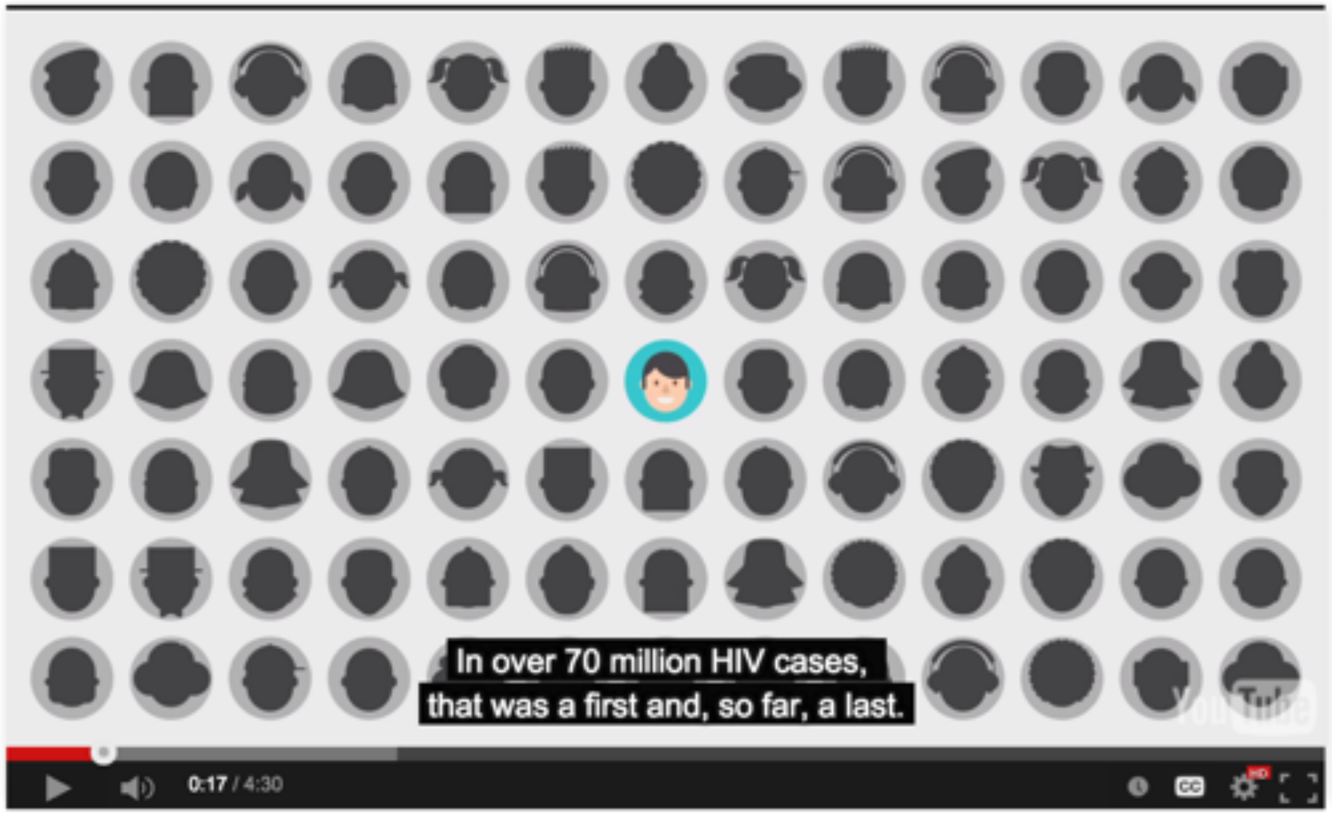
Dig Deeper

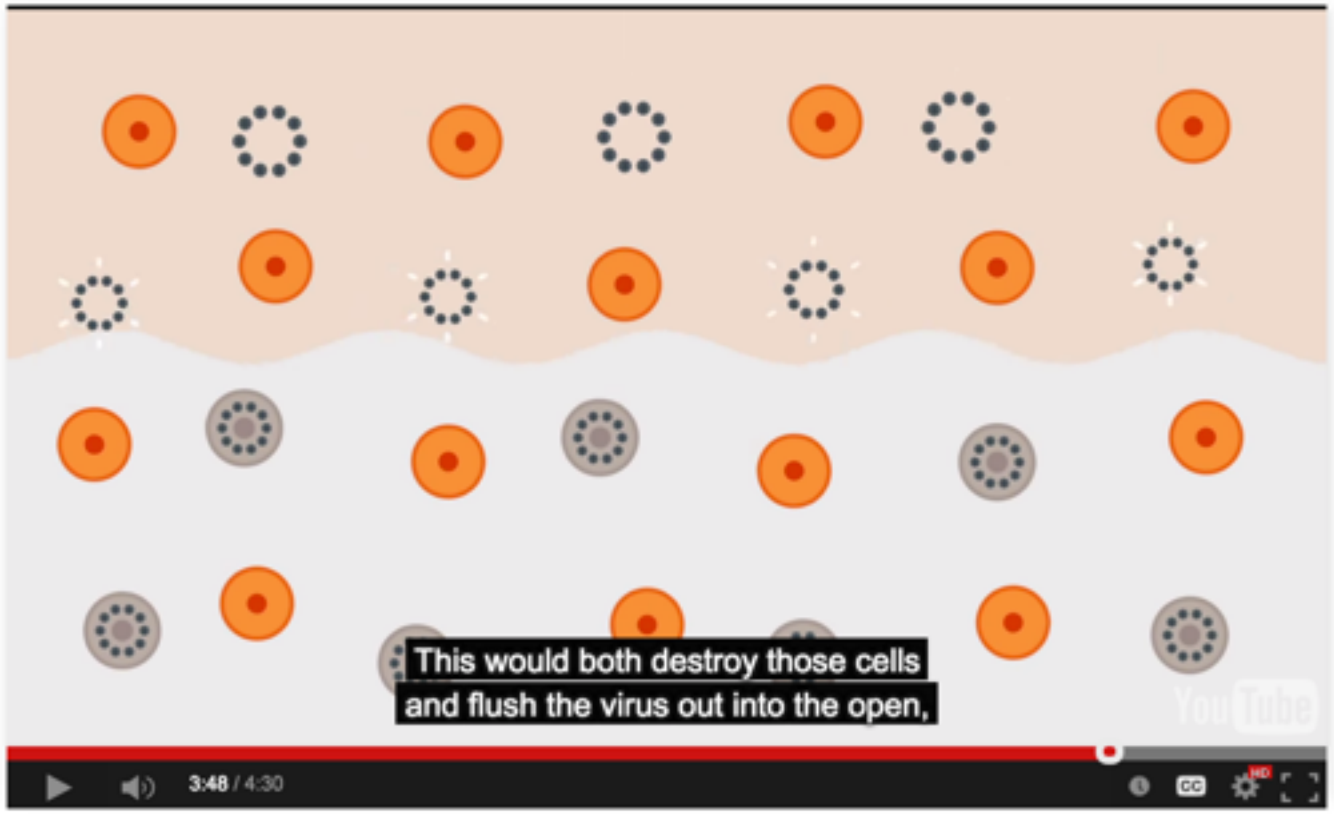
Discuss

Customize This Lesson 21

Create and share a new lesson based on this one.

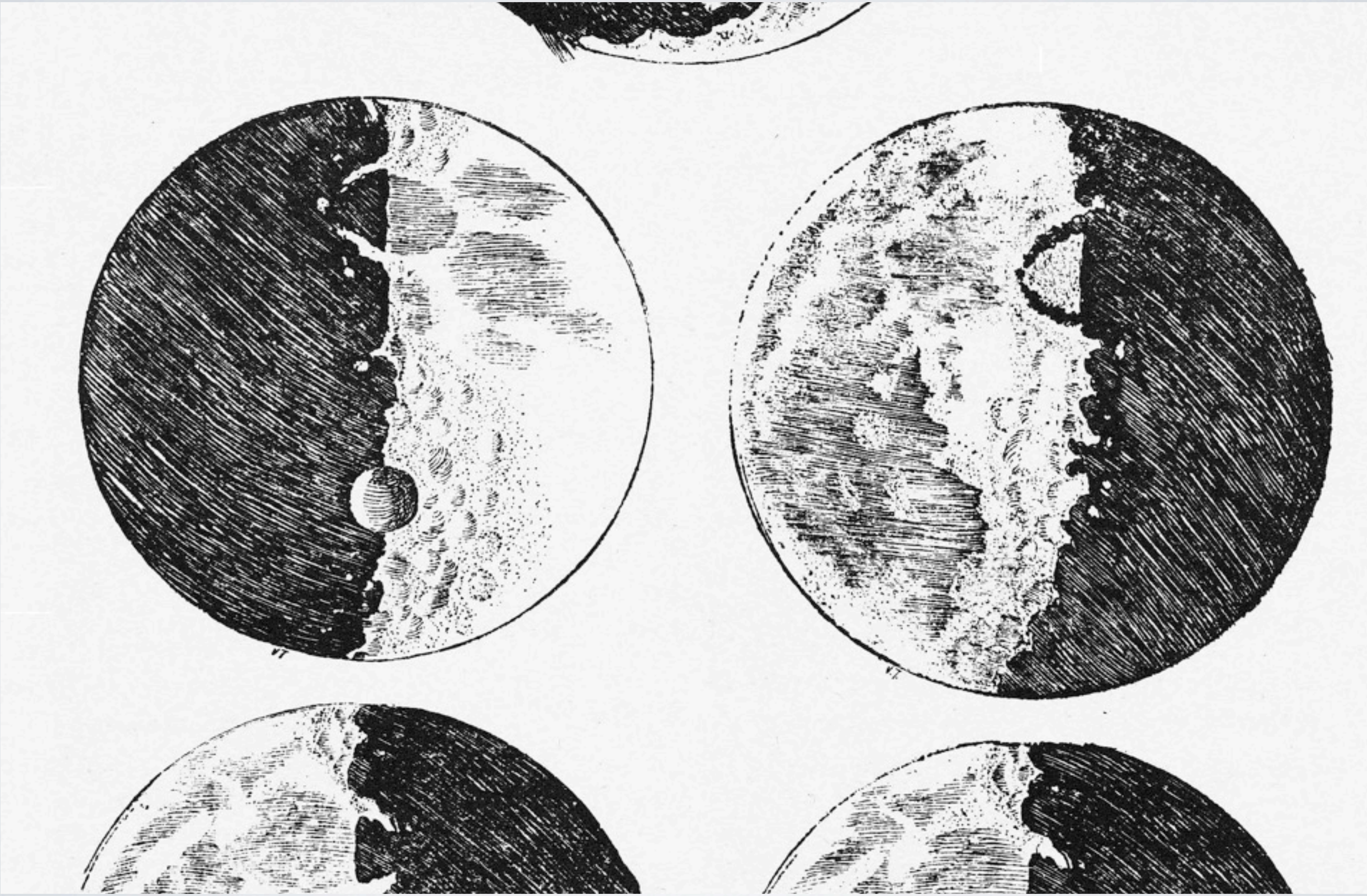
ANIMATION SCREENSHOTS





with TED Ed & Javier Saldeña

THE SCIENTIST AS ARTIST



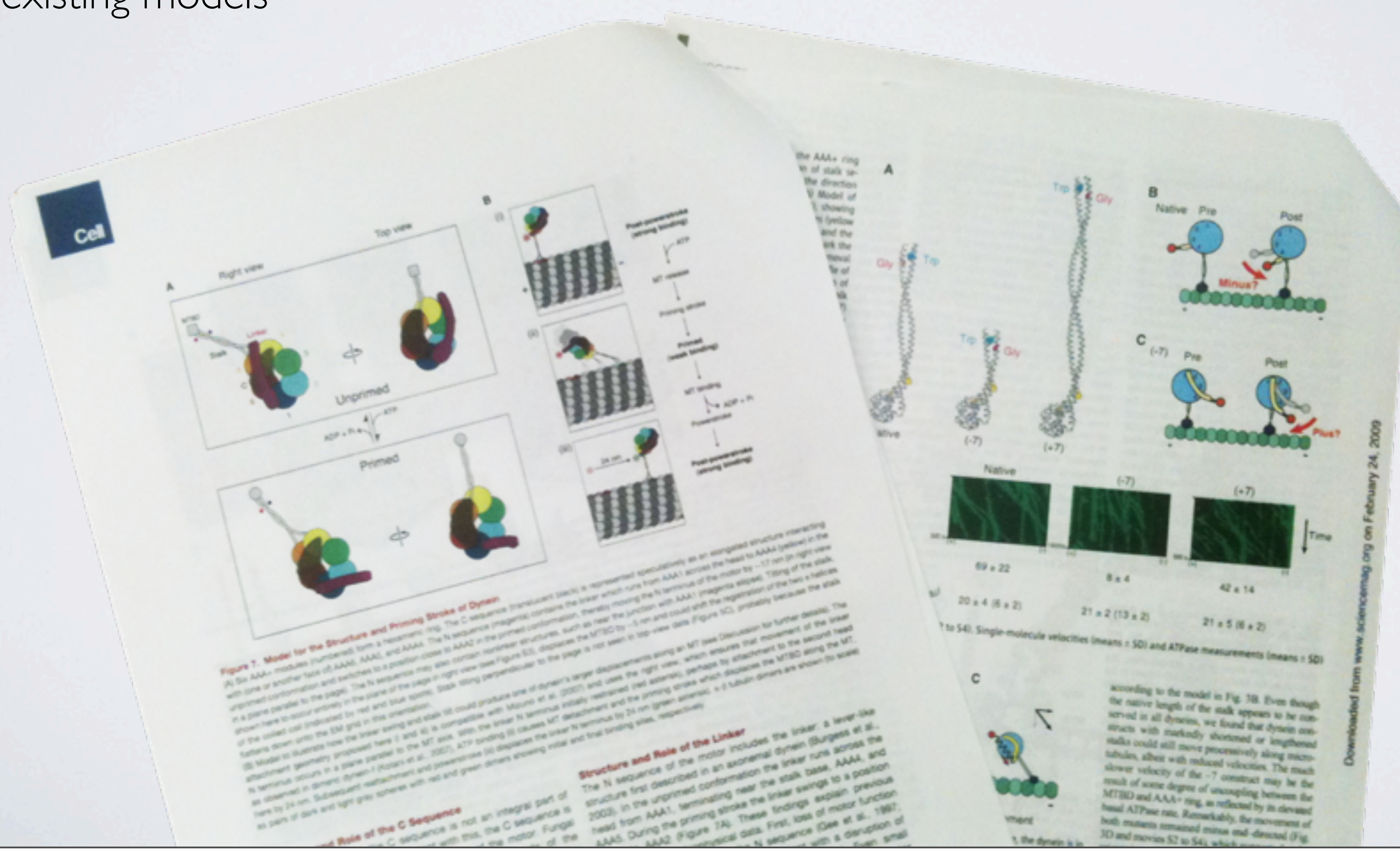
THE ROLE OF THE MODEL FIGURE

Benefits for the audience

- a description of the current understanding of a process

- background and context

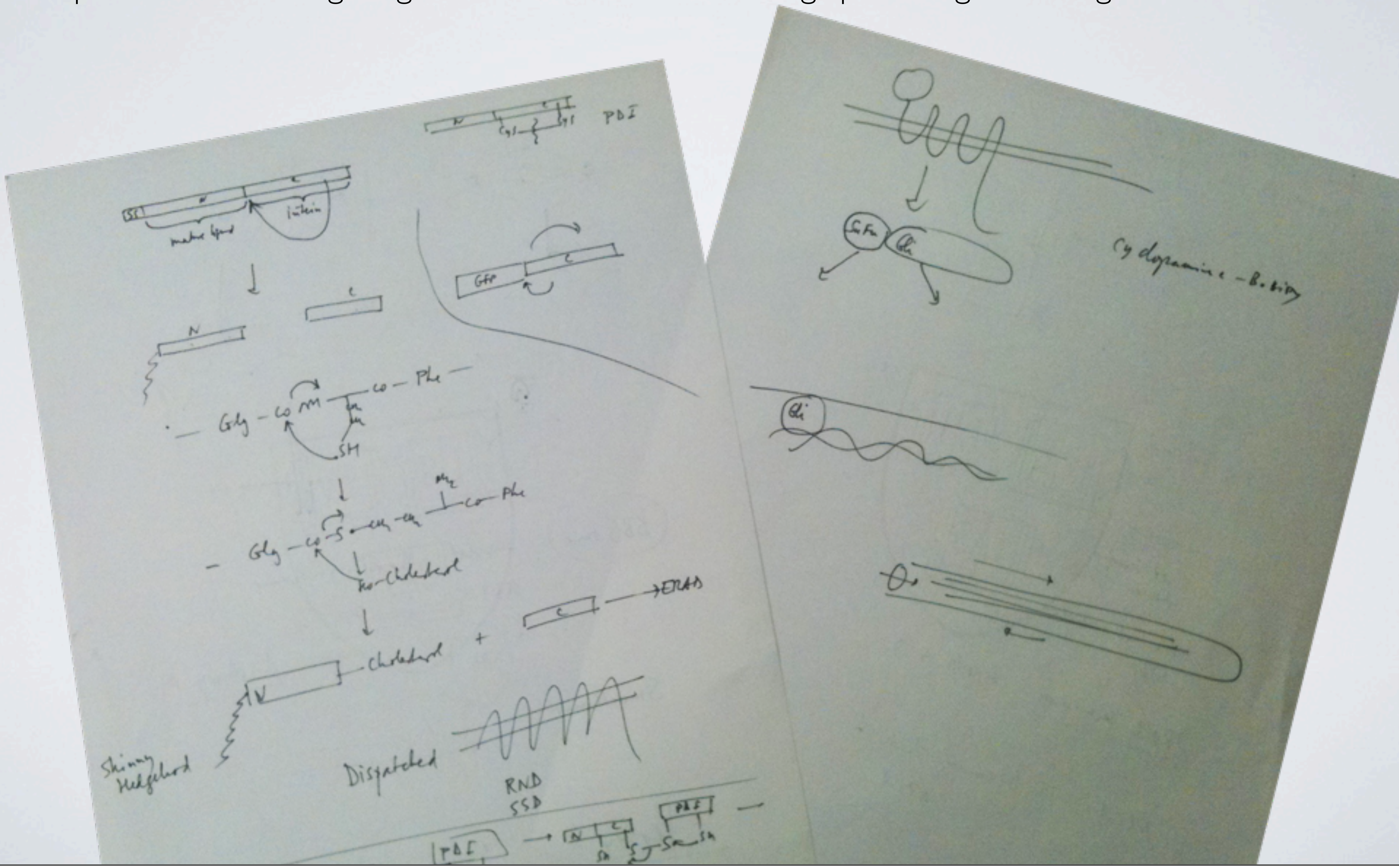
- an understanding of the authors' specific hypothesis, and how it adds to or alters existing models



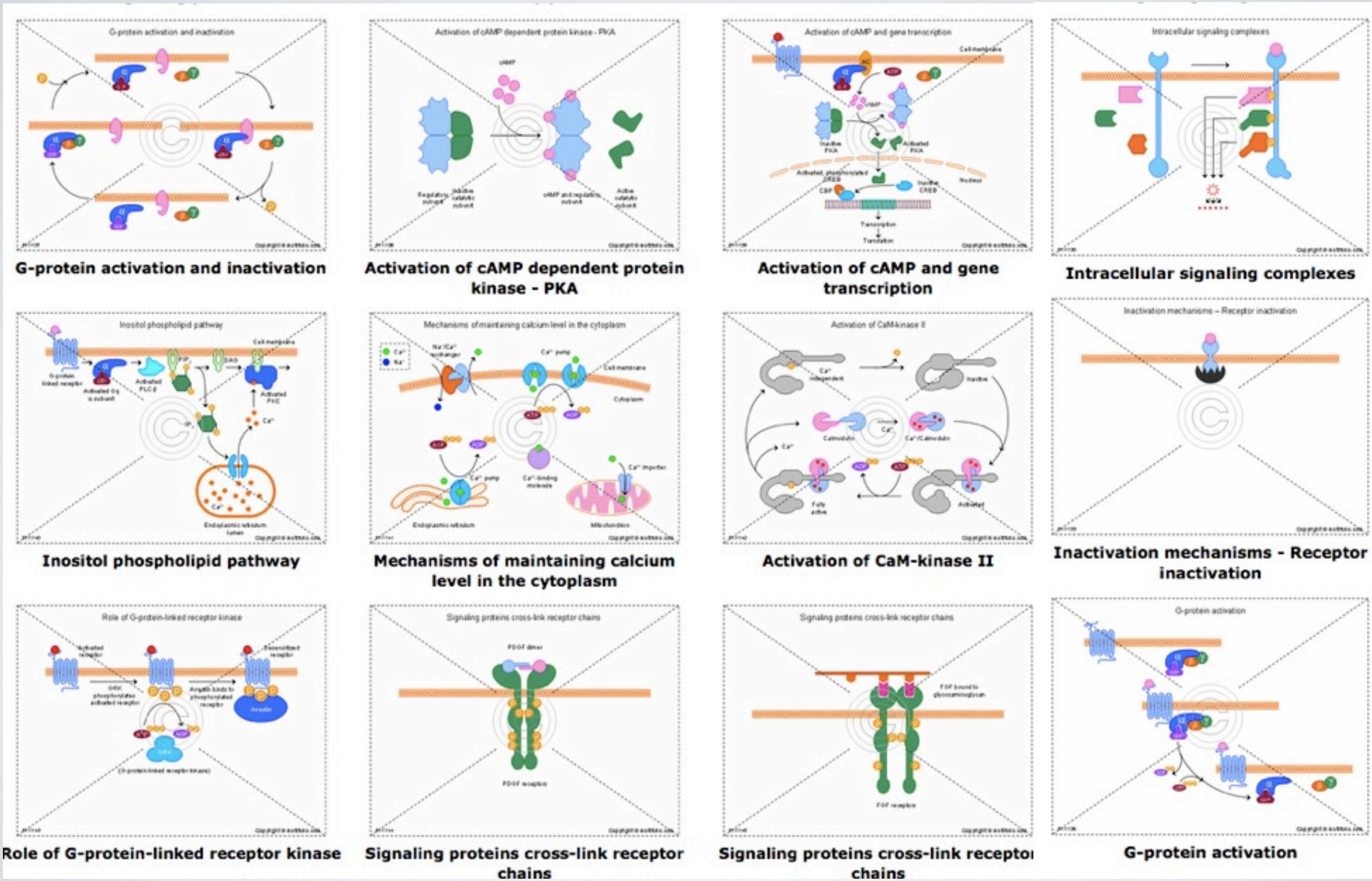
THE ROLE OF THE MODEL FIGURE

Benefits for the author

- process of drawing a figure can often be illuminating, providing new insights



INSTANT MODEL FIGURES?



motofolio.com

MOLECULAR FLIPBOOK

a community resource for creating & sharing molecular animations

(1) A 3D ANIMATION TOOLKIT

which will allow biologists to readily create molecular and animations using open-source animation software

(2) A WEBSITE AND DATABASE

where users can upload and share their animation scene files and completed animations

MOLECULAR FLIPBOOK TOOLKIT

a community resource for creating & sharing molecular animations

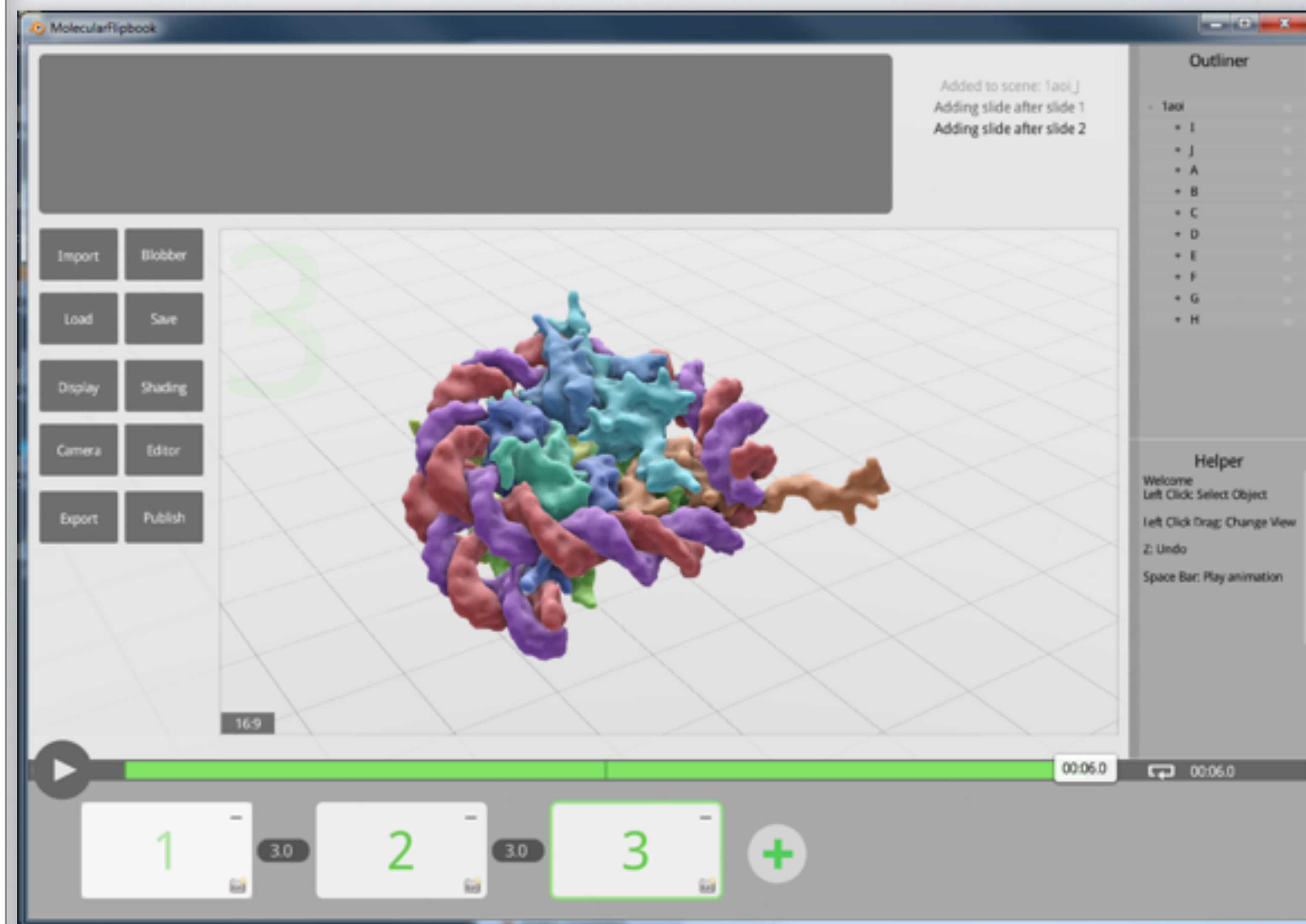
- suite of molecular animation tools built in Blender's game engine which will include import, modeling, animation and rendering modules.

- intuitive interface, simple controls

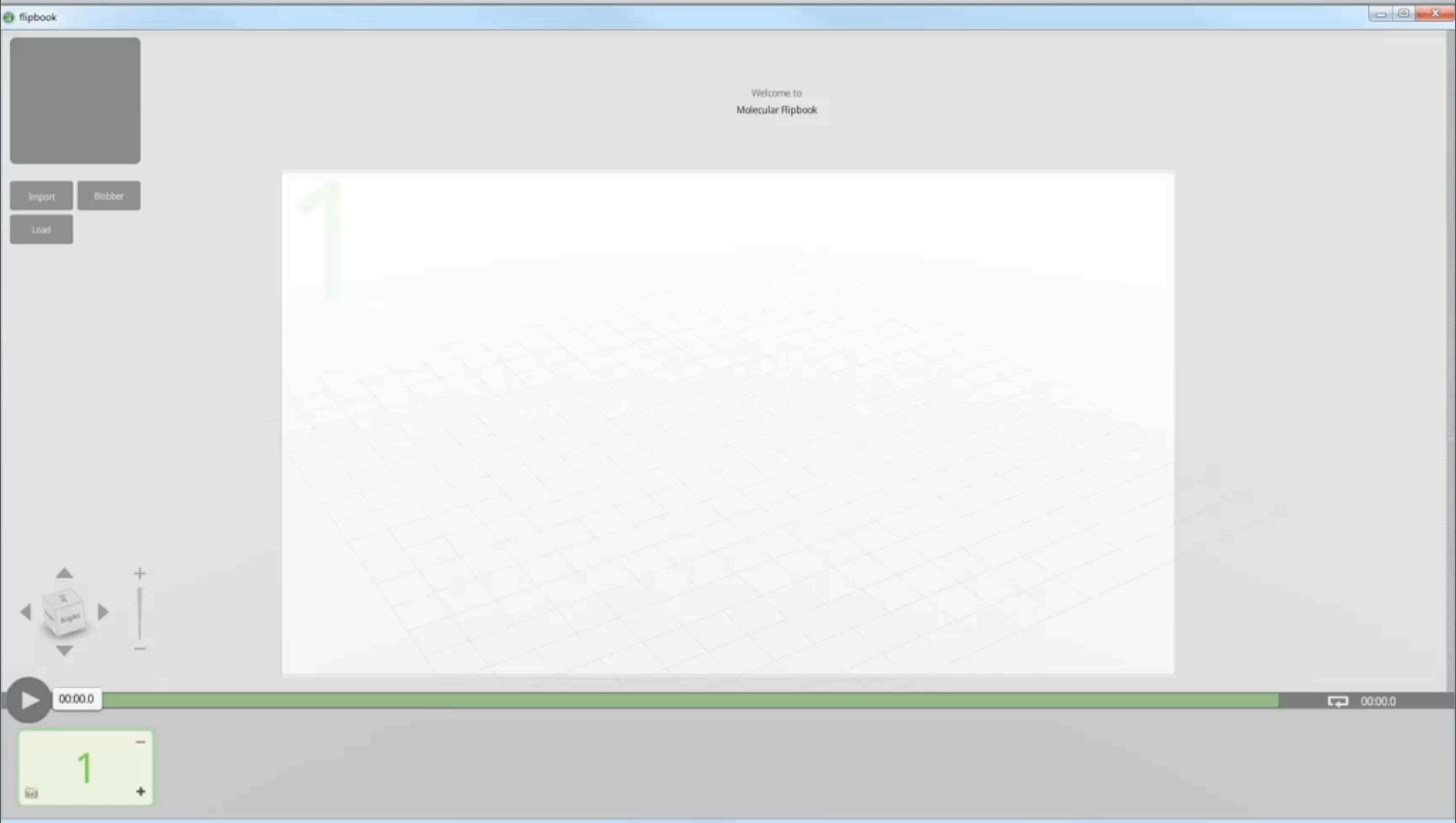
- ability to start creating animations after watching a short video tutorial.

Primary challenge:

How do we make 3D animation intuitive for users new to animation (and to those returning after a long break)?



MOLECULAR FLIPBOOK TOOLKIT



MOLECULAR FLIPBOOK TOOLKIT

a community resource for creating & sharing molecular animations

Molecular Flipbook Toolkit Features (Beta Version)

PDB import

Upload molecular structures as PDB files, either from your computer or from the Protein Data Bank database.

In-app tutorials

The in-application tutorials launch automatically and will walk you through how to use Flipbook.

Slide-based animation

If you've ever used Powerpoint or Keynote, you'll already be an expert in creating animations in Molecular Flipbook.

Blobber tool

Create a "blobby" as a stand-in for proteins that you don't have a structure file for. All you need to know is a molecular weight or approximate dimensions to create a blobby!

Save your animation as a video

Once you create your animation, you can export it as a movie file that you can then embed in presentations and share with others!

Create protein markers

Create and animate protein markers that can indicate, for example, where post-translational modifications are made.

Animate colors and shaders

It's easy to animate your molecules changing color (to signify activation, for example) and to change its look using the Shader tool.

Features that we're currently working on

To be notified when we release updated versions of Molecular Flipbook, please fill out our Feedback form.

Linker tool

Create a dynamic and flexible linker that connects two domains of a protein.

Create biological units

Create larger biological assemblies (of virus capsids, for instance) using the BIOMT coordinates inside a PDB.

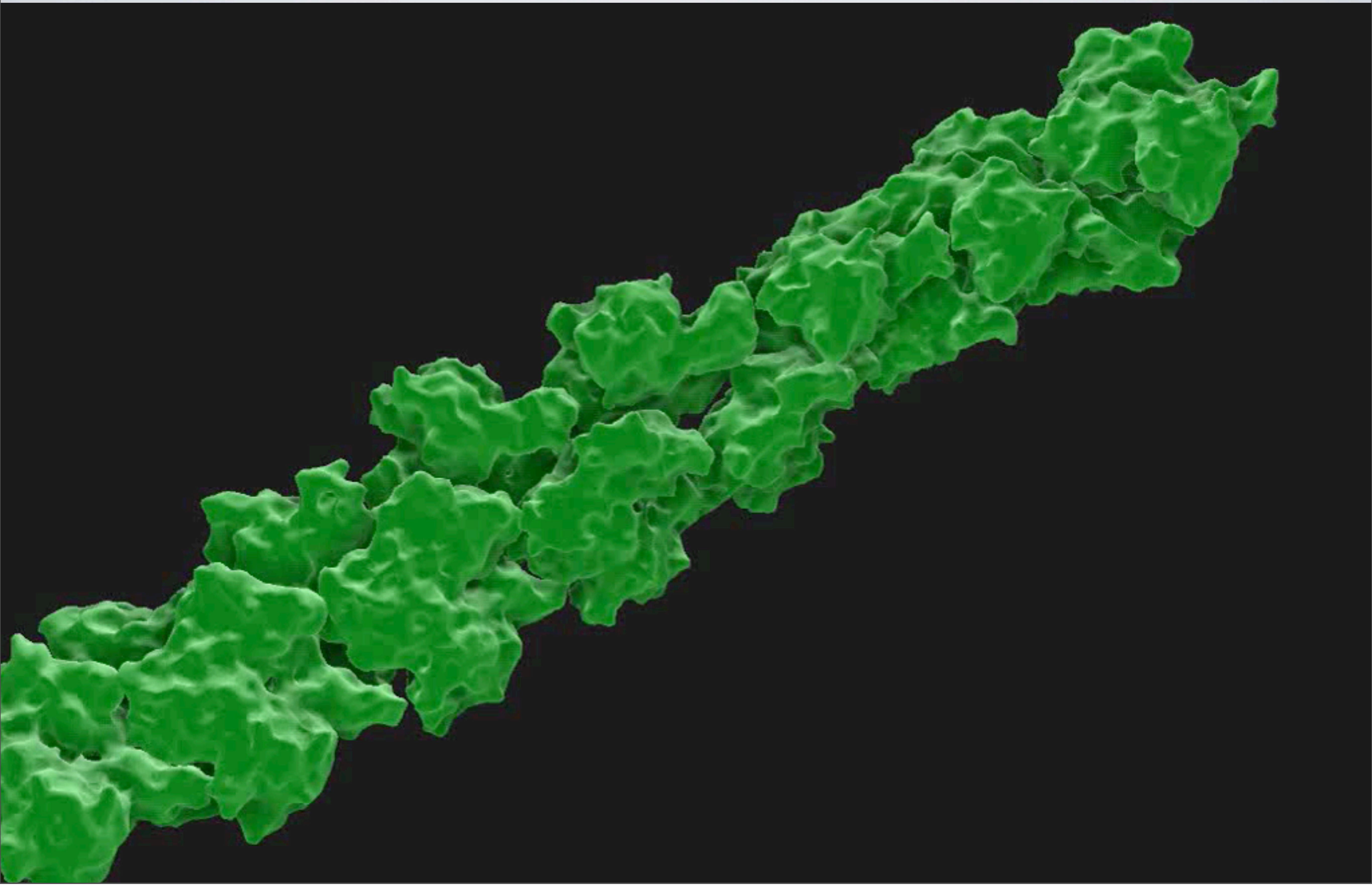
Import additional filetypes

Import geometry files, such as reconstructions from the EMDB, or other files (such as .stl) that may have been generated in another program.

Cut chains

Create two different surfaces from a single chain – this can be useful to animate

MOLECULAR FLIPBOOK EXAMPLE



MOLECULAR FLIPBOOK TOOLKIT

a community resource for creating & sharing molecular animations

http://MolecularFlipbook.org

MOLECULAR FLIPBOOK

Download a beta version of the Molecular Flipbook toolkit - it's free and open source.

Download Molecular Flipbook for Mac

Click to download the Mac version of the Molecular Flipbook Beta 0.1 Animation Toolkit!

Download Flipbook for Mac

Download Molecular Flipbook for PC

Click to download the Windows version (64bit only) of the Molecular Flipbook Beta 0.1 Animation Toolkit!

Download Flipbook for PC

Molecular Flipbook Toolkit Features (Beta Version)

PDB import

Upload molecular structures as PDB files, either from your computer or from the

In-app tutorials

The in-application tutorials launch automatically and will walk you through

Slide-based animation

If you've ever used Powerpoint or Keynote, you'll already be an expert in creating

MOLECULAR FLIPBOOK WEBSITE

a community resource for creating & sharing molecular animations

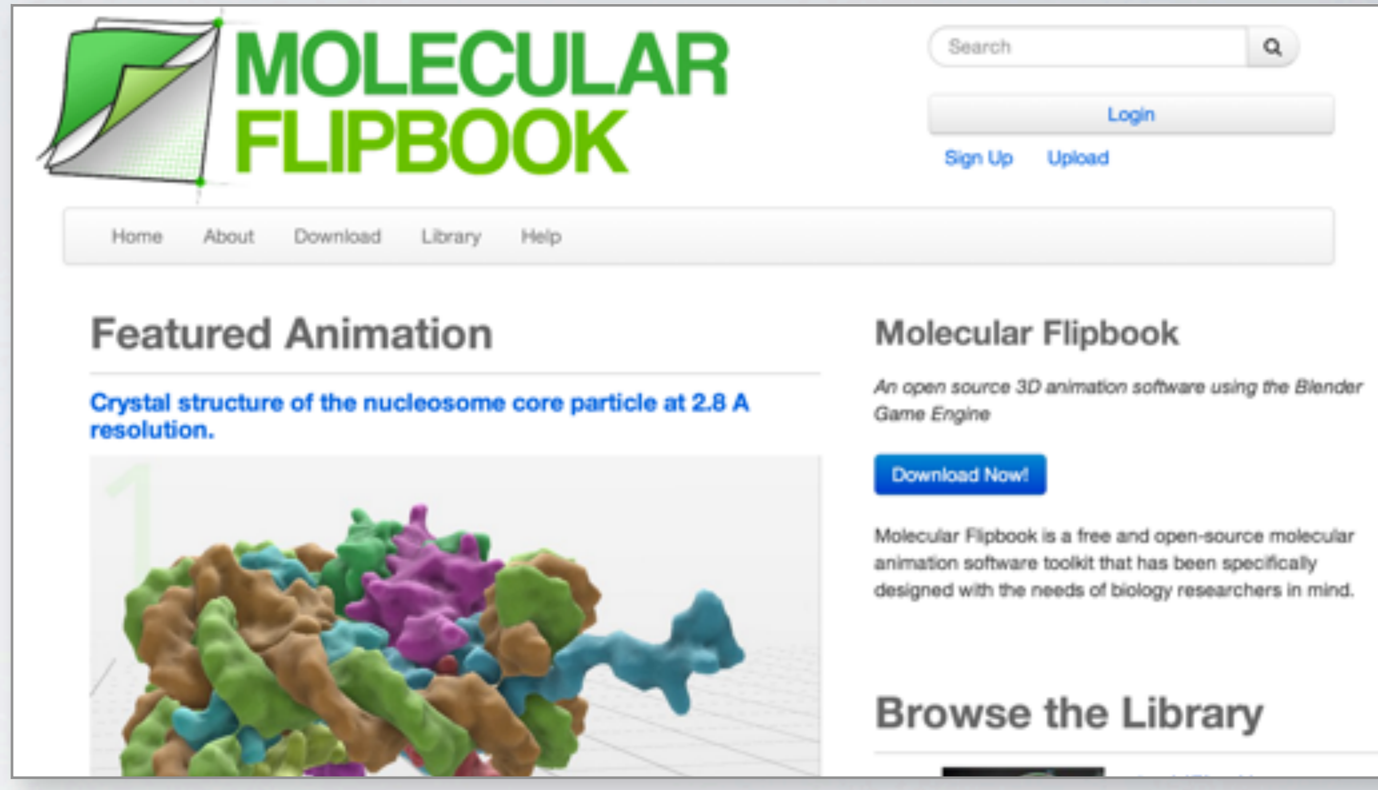
- searchable, easy-to-use online database that also hosts community/social interactions/ collaborations

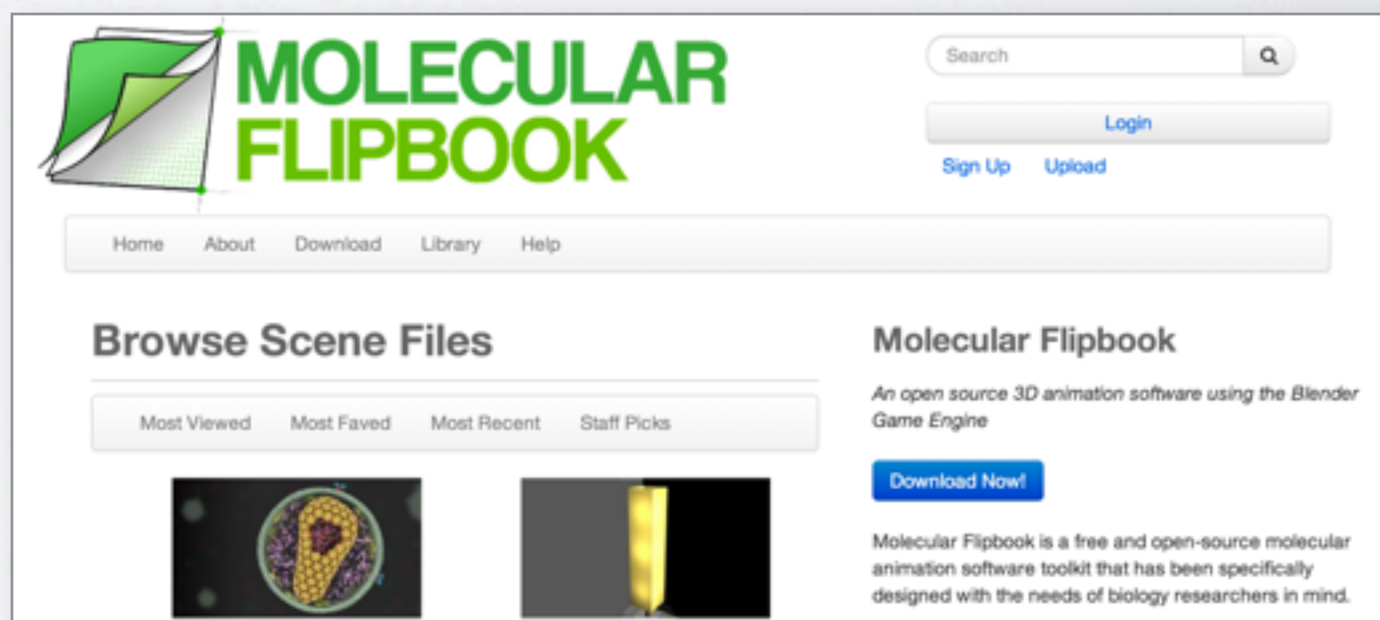
- will allow users to share not only Blender-based animation, but also Illustrator, Photoshop files, etc.

- provides a visual way of following the evolution of a hypothesis over time

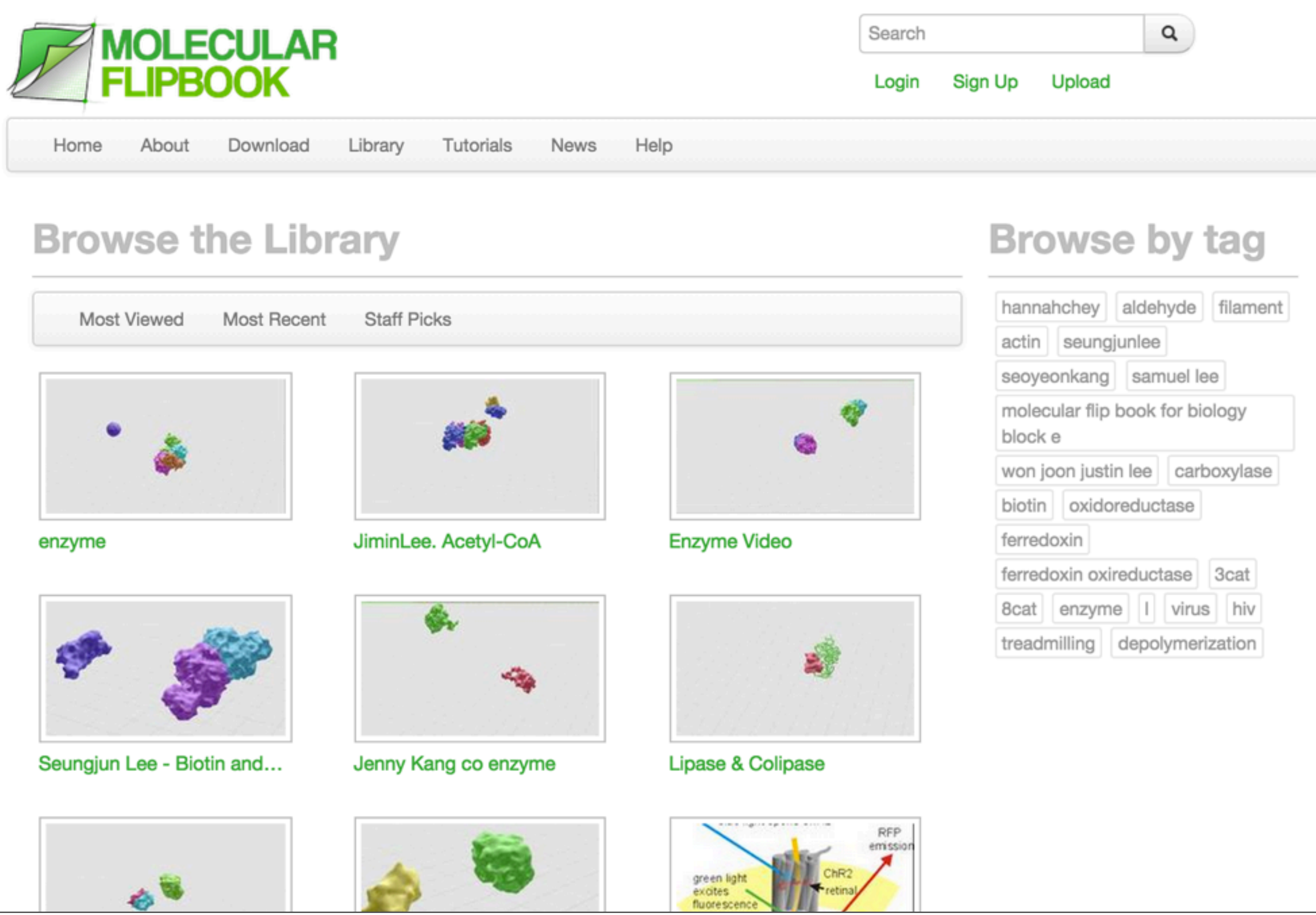
Primary challenge:

How do we get users to share their visualizations with others?





MOLECULAR FLIPBOOK WEBSITE



TOWARDS A DIGITAL CELL

TOOLS

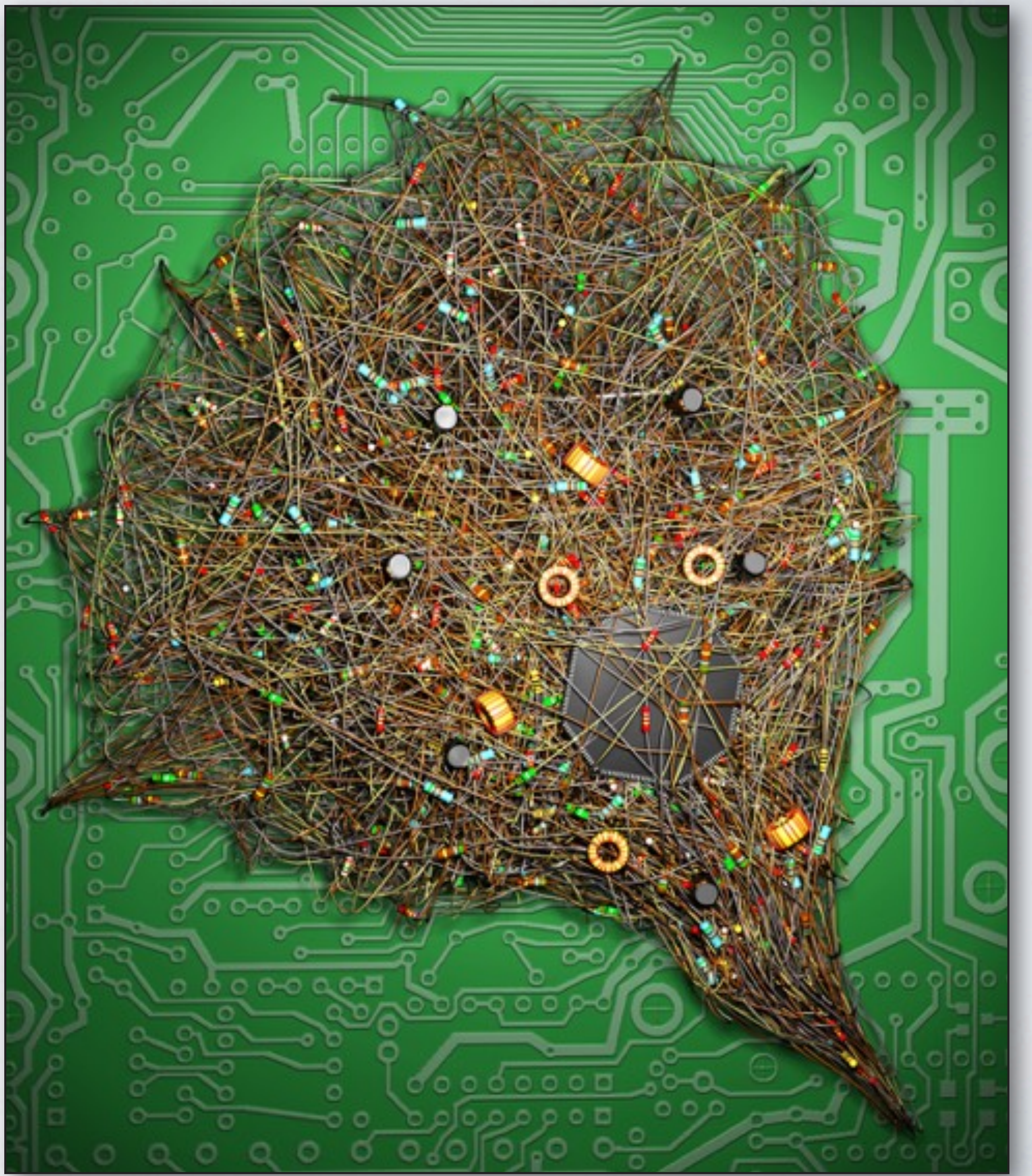
intuitive animation/visualization tools that could allow integration of multiscale data from different sources

TRANSPARENCY

standardized means of providing references and sources used in visualizations

ARCHIVES

centralized repository for cellular data, images and animations



MANY THANKS

Tom Kirchhausen Harvard Medical School
Wes Sundquist, Michael Kay and the CHEETAH Consortium University of Utah
Molecular Flipbook Team: Mike Pan, Rise Riyo, Gaël McGill (HMS), **Piotr Sliz** (HMS)
Sam Reck-Peterson Harvard Medical School
Jack Szostak Massachusetts General Hospital/Harvard Medical School

National Science Foundation
National Institutes of Health (NIGMS)
The TED Fellows Program

LINKS

University of Utah website: http://biochem.web.utah.edu/iwasa

The Science of HIV Project: http://ScienceofHIV.org

The Molecular ViewBook Project: http://MolecularFlipbook.org

The Exploring Origins Project: http://ExporingOrigins.org

Tutorials, Movies and Molecular Maya: http://molecularmovies.org