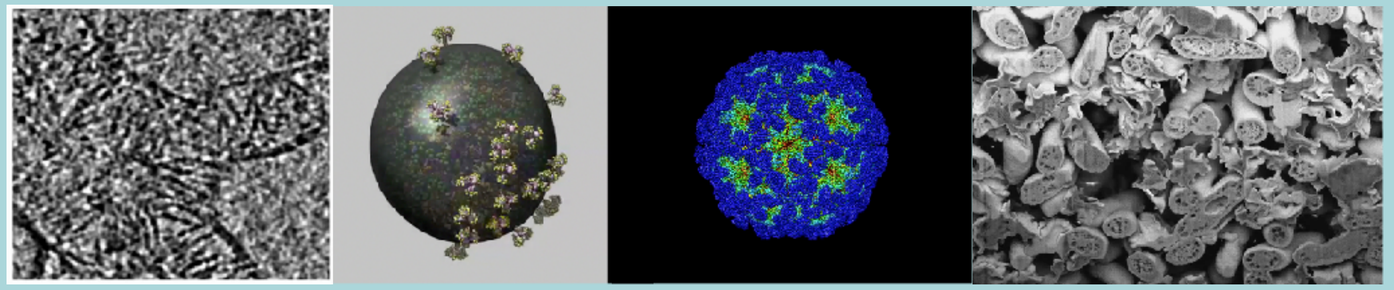
2020 Winter-Spring EM Course



Edward T Eng
January 06, 2020

Simons Electron Microscopy Center

NEW YORK STRUCTURAL BIOLOGY CENTER

Welcome to electron microscopy at SEMC

1. Welcome new students
2. Course logistics
3. Introduction to EM and Roundtable
4. Tour of the facility

NMR

CoMD/ NMR

X-ray

NYX @NSLS-II

Protein Production

COMPPÅ

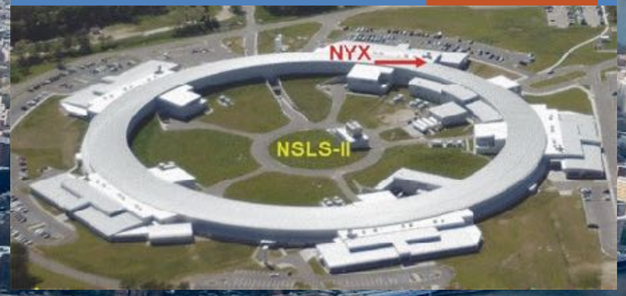
NIH P41 - National Biomedical Technology Research Resources (BTRR)

National Synchrotron Light Source II

BROOKHAVEN NATIONAL LABORATORY

19-ID

NYX



NRAMM

photo by Swapnil Bhatkar

NMR
CoMD/ NMR

X-ray
NYX @NSLS-II

Protein Production
COMPPÅ

NIH P41 - National Biomedical Technology Research Resources (BTRR)

15th year of the course

photo by Swapnil Bhatkar

NCCAT

NRAMM

Course logistics

- Questionnaire
  - email list
  - SEMC Winter-Spring EM Course Handbook
- Active research facility
  - public areas

Course logistics: main website

semc.nysbc.org/the-winter-spring-2020-em-course/

SIMONS ELECTRON MICROSCOPY CENTER

HOME ABOUT USER RESOURCES PUBLICATIONS INSTRUMENTATION NEWS & EVENTS FAQ

EVENTS

Upcoming Events

News and Past Events

Forums

Workshops and Courses

Workshops and Symposia at Outside Organizations

The Winter-Spring 2020 EM Course

General registration for the 2020 winter course is closed. If you registered for this course through your institution's registrar (with a cutoff in January), then please let us know as we have separate reserved spots for students taking the course for academic credit.

About the course

Electron microscopy in combination with image analysis is increasingly powerful in producing 3D structures of individual molecules and large macromolecular complexes that are unapproachable by other methods. This course is focused on the concepts and theories behind electron microscopy and will be taught in a reverse classroom format based on Grant Jensen's online course (Getting Started in Cryo-EM from Caltech). Students will be responsible for watching these online lectures prior to class. Each week guest lecturers and SEMC staff lead discussions on the practice of solving molecular structures by electron microscopy.

The course will be held at the New York Structural Biology Center at 89 Convent Ave (133rd St).

Course Schedule

Classes in SEMC or NYSBC seminar rooms (Winter course: Mondays 3:30-5pm and Wednesdays 3:30-5pm | Short course weeks: 9:30am-11am)

EM fundamentals section (month of January)

Jan 6 : Lecture – Introduction & SEMC tour (Ed Eng – NYSBC)
Jan 8 : *Practical* – Sample Preparation & Support films (Micah Rapp/Ed Eng – COLU/NYSBC)
Jan 13 : Lecture – Basic anatomy of the electron microscope (Micah Rapp – COLU)
Jan 15 : *Practical* – TEM use
Jan 20 : *MLK Jr holiday – No class*

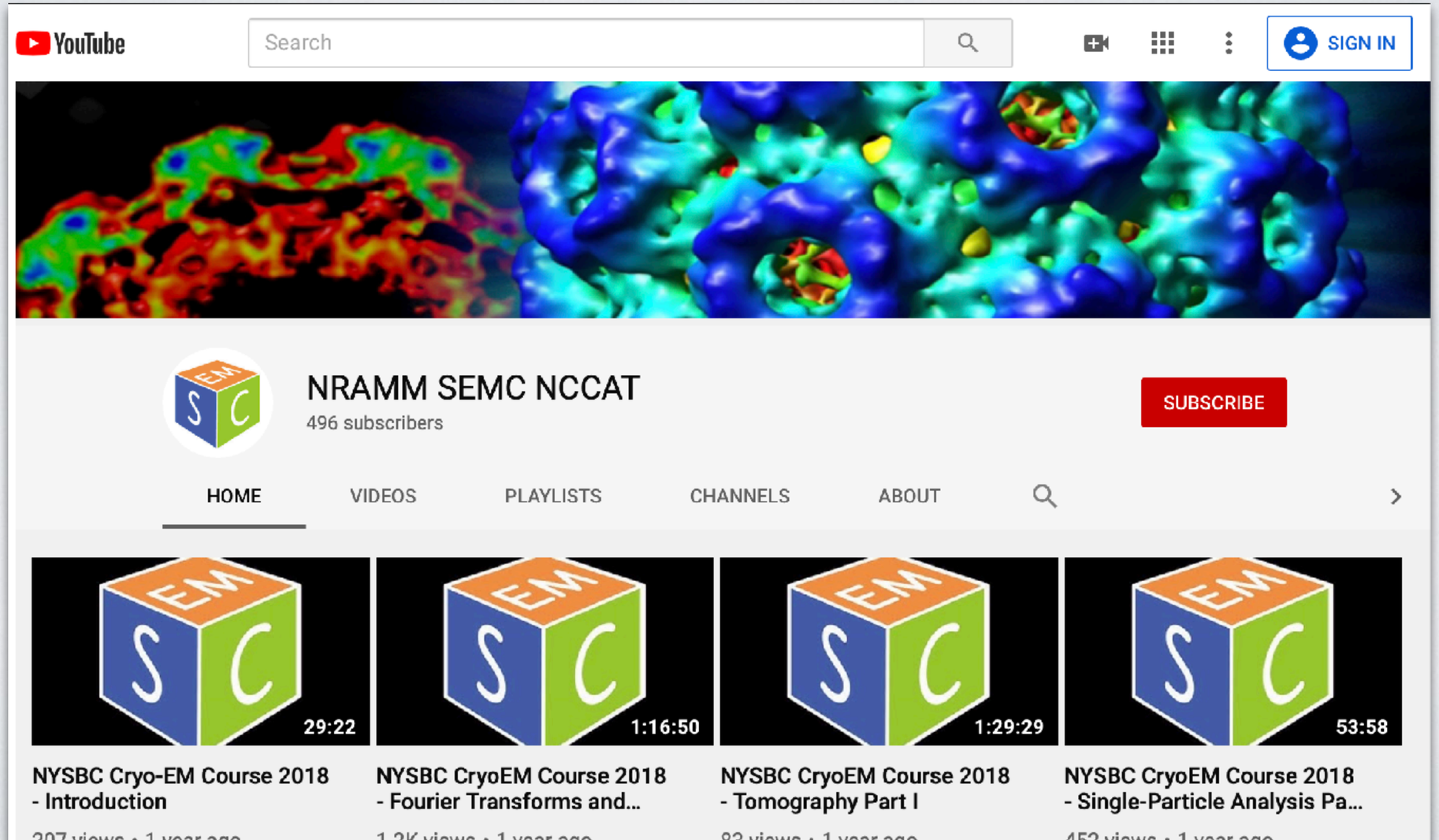
Course Administrator:
Ed Eng (eeng@nysbc.org)

Teaching Assistant:

Micah Rapp
(mar2294@columbia.edu)

Course logistics: live stream

youtube.com/nrammsemc



Course logistics

Section 1a : EM fundamentals section
b : 2D EM section
c : *SEMC Appion workshops*
d : *SEMC journal clubs*

Section 2 : Single-particle short-course

Section 3 : Tomography short-course

Course logistics

Mondays
3:30-5pm - A-11 seminar room / SEMC conference room

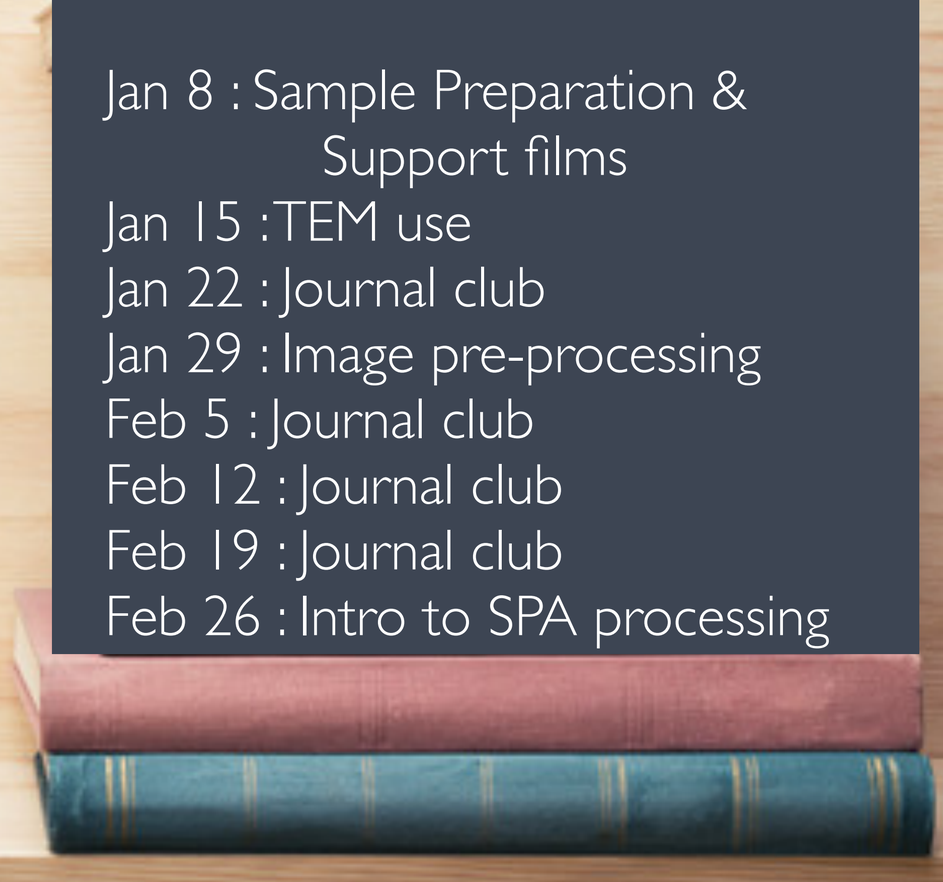
Wednesdays
Starts at 3:30 - SEMC conference room

Lecture schedule

Jan 6 : Introduction & SEMC tour
Jan 13 : Basic anatomy of the electron microscope
Jan 20 : *MLK Jr holiday – No class*
Jan 27 : Fourier transforms and Image Formation
Feb 3 : MicroED (Bill Rice – NYU)
Feb 10: Helical reconstruction (Hernando Sosa – Einstein)
Feb 17 : *President's day holiday – No class*
Feb 24 : Q&A – open forum & primer to SPA

Recitation schedule

Jan 8 : Sample Preparation & Support films
Jan 15 : TEM use
Jan 22 : Journal club
Jan 29 : Image pre-processing
Feb 5 : Journal club
Feb 12 : Journal club
Feb 19 : Journal club
Feb 26 : Intro to SPA processing



Course logistics: class for credit

Component	Percentage
Recitation	50%
- *JC/HW/questions*	
Practical Worksheet	10% x 4
Attendance	10%

Wednesdays

Starts at 3:30 - SEMC conference room

Recitation schedule

Jan 8 : Sample Preparation & Support films
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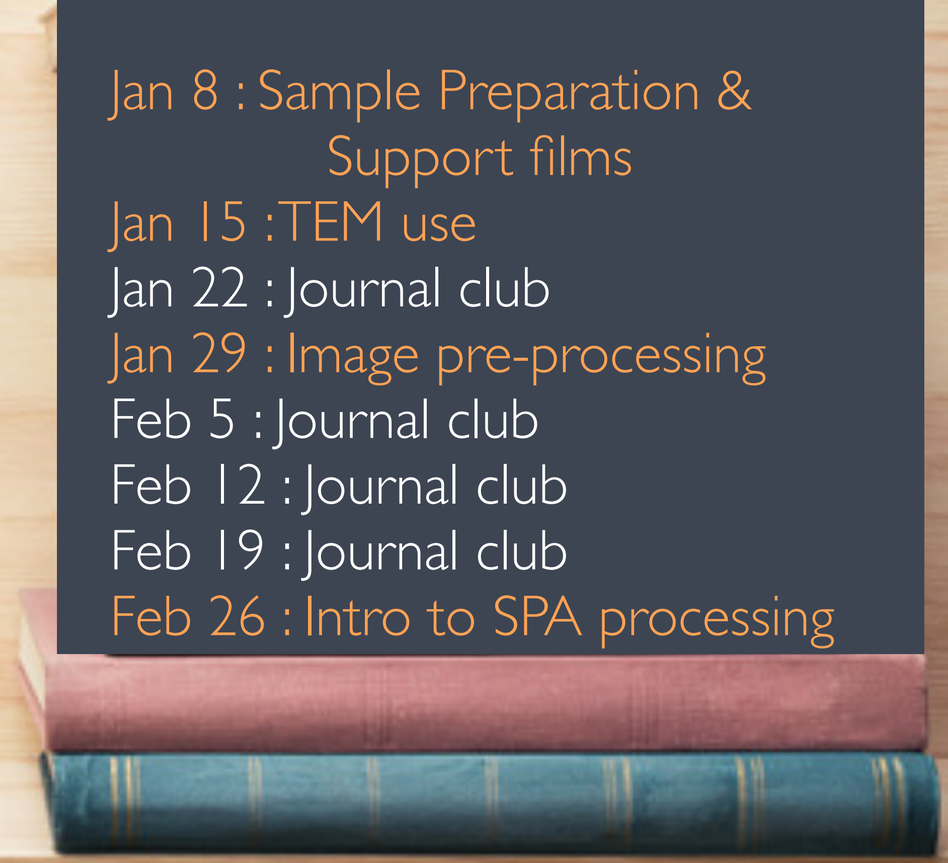


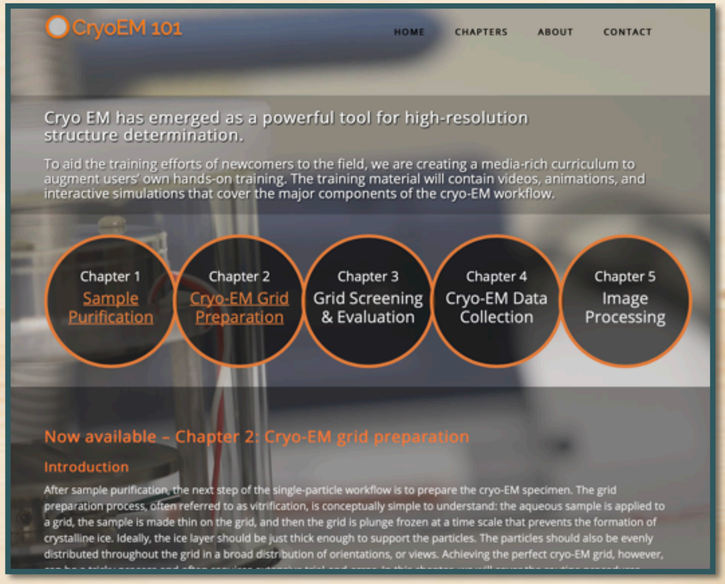
Course logistics: recitations

cryo-em-course.caltech.edu/videos

Part 4: Fundamental Challenges in Biological TEM & Sample Prep

Unit 2: Sample Preparation - youtube.com/playlist?list=PL8_xPU5epJdfd5fM2CjQItR-iRIIEIJk8

cryoem101.org



Chapter 1: Sample Purification

Chapter 2: Cryo-EM Grid Preparation

Wednesdays

Starts at 3:30 - SEMC conference room

Recitation schedule

Jan 8 : Sample Preparation & Support films

Jan 15 : TEM use

Jan 22 : Journal club

Jan 29 : Image pre-processing

Feb 5 : Journal club

Feb 12 : Journal club

Feb 19 : Journal club

Feb 26 : Intro to SPA processing

Course logistics: recitations

SEMC conference room

Wednesdays

Starts at 3:30 - SEMC conference room

Recitation schedule

Jan 8 : Sample Preparation & Support films

Jan 15 : TEM use

Jan 22 : Journal club

Jan 29 : Image pre-processing

Feb 5 : Journal club

Feb 12 : Journal club

Feb 19 : Journal club

Feb 26 : Intro to SPA processing

Course logistics

Section 1a : EM fundamentals section
b : 2D EM section
c : *SEMC Appion workshops* - ***Jan 30***

https://www.surveymonkey.com/r/BHVHYK3

Section 2 : Single-particle short-course - March 2

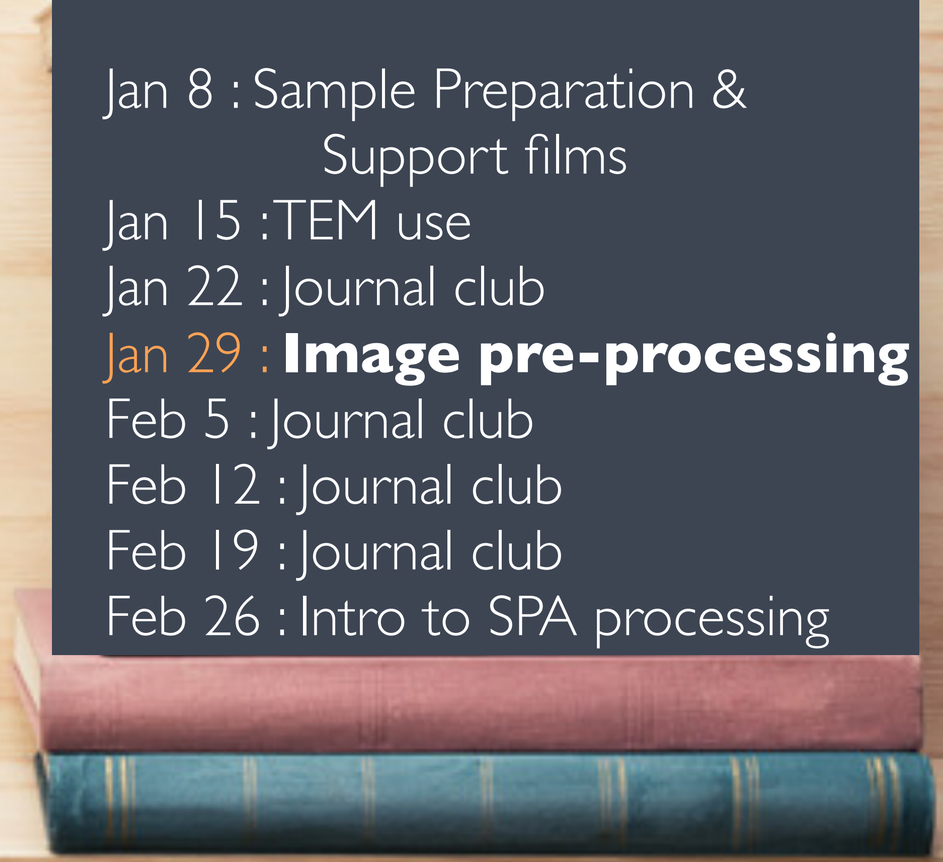
1d : **Additional journal clubs**

Section 3 : Tomography short-course - April 13

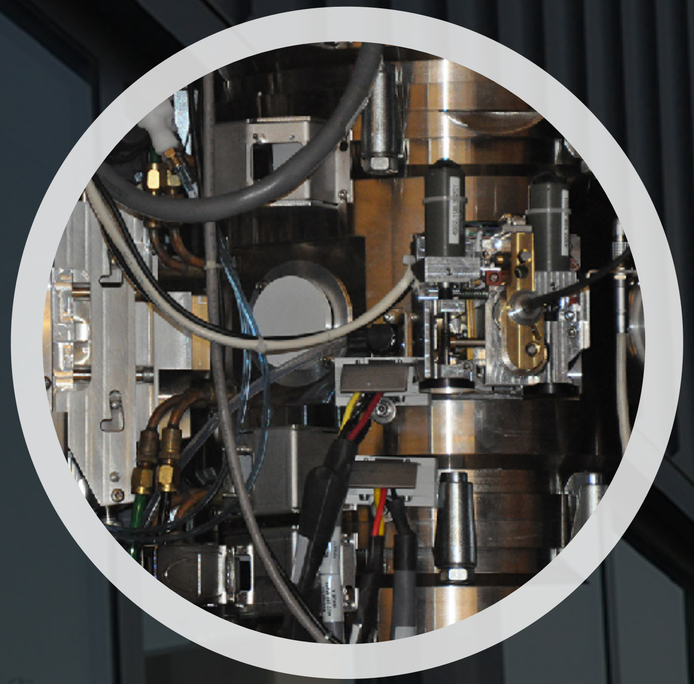
1e : **Course wrap up** - TBD

Recitation schedule

Jan 8 : Sample Preparation & Support films
Jan 15 : TEM use
Jan 22 : Journal club
Jan 29 : **Image pre-processing**
Feb 5 : Journal club
Feb 12 : Journal club
Feb 19 : Journal club
Feb 26 : Intro to SPA processing



CAT



cryoEM short courses

1 WEEK SHORT COURSES

MORNING LECTURES & ROUNDTABLES

AFTERNOON HANDS-ON PRACTICALS

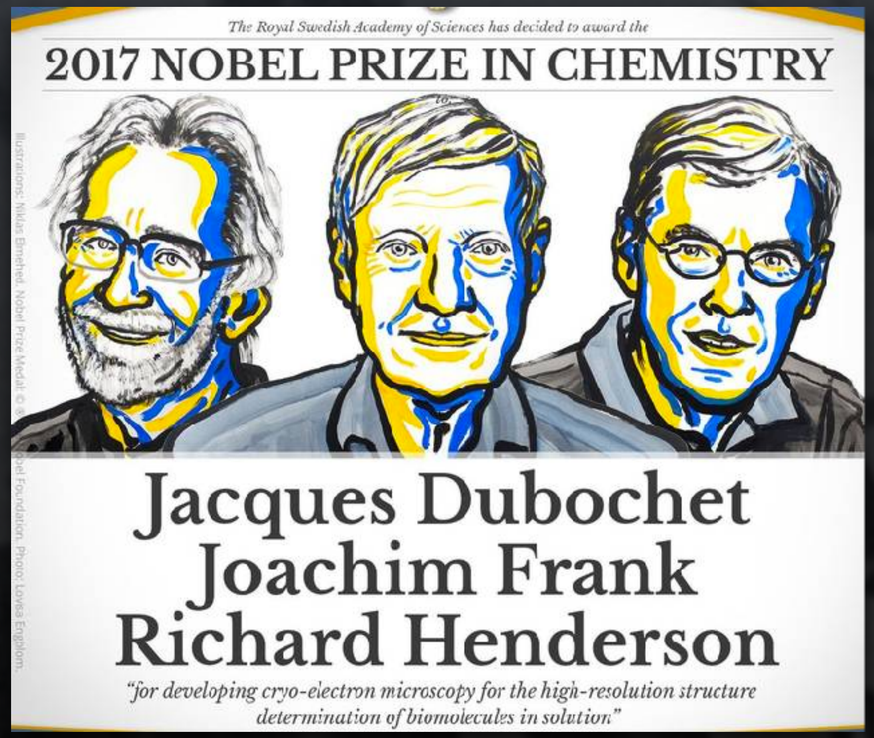
Welcome to electron microscopy at SEMC

1. Welcome new students
2. Course logistics
3. **Introduction to EM and Roundtable**
4. Tour of the facility

CRYOEM: TECHNOLOGY ON THE RISE

Single-particle cryo-electron microscopy (cryoEM) is the Method of the Year 2015

Chemistry Nobel prize 2017

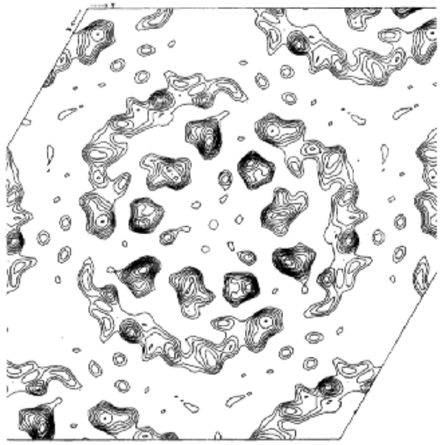


microED
Science breakthrough of the year runner-up 2018

Ruska and Knoll in Berlin in the early 1930s

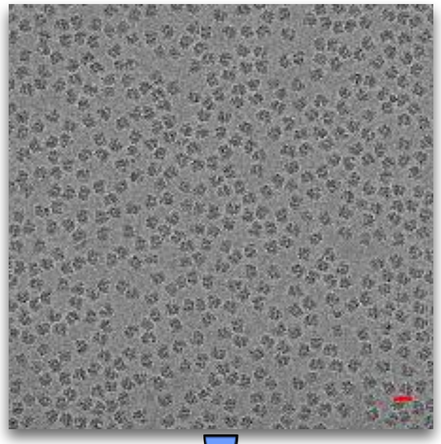
CRYOEM: TECHNOLOGY ON THE RISE

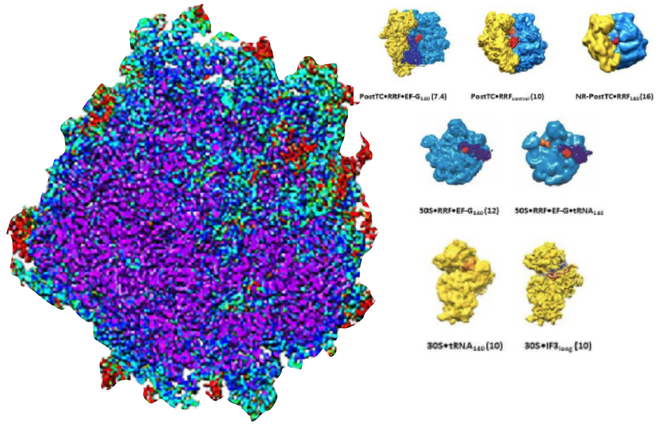
1986



Henderson et al. (1986)

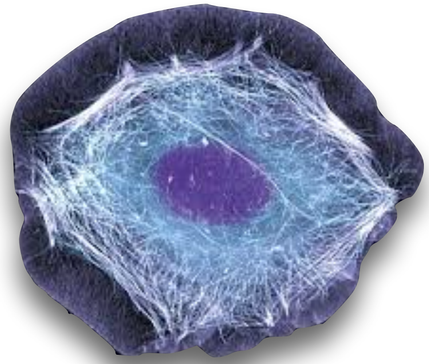
2017

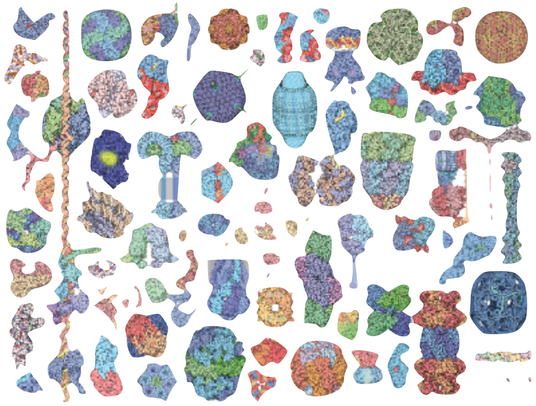




Frank et al. (2017)

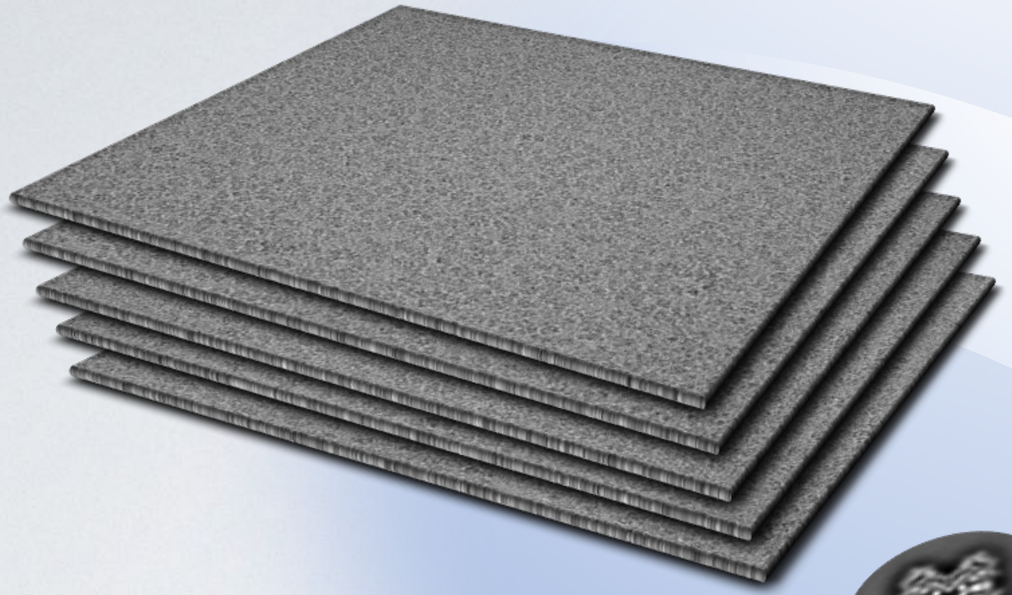
????

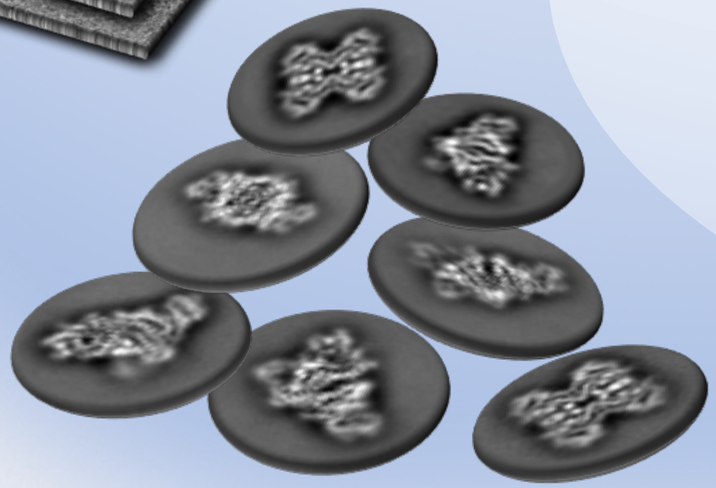


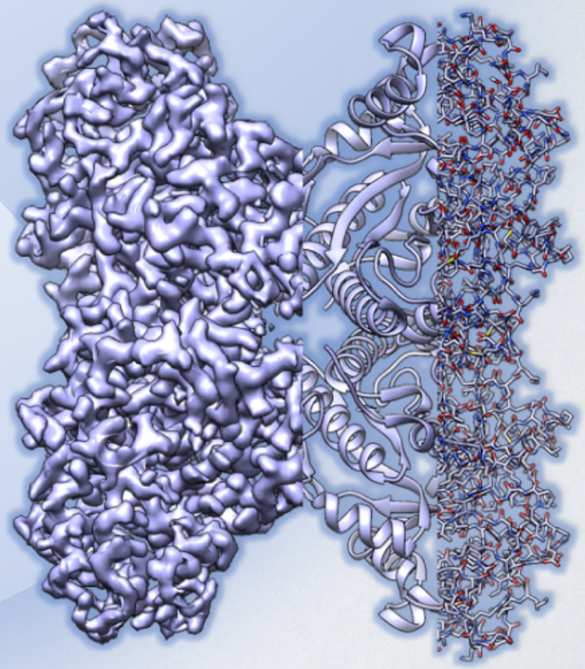


TBD (20??)

WHAT IS POSSIBLE TODAY?





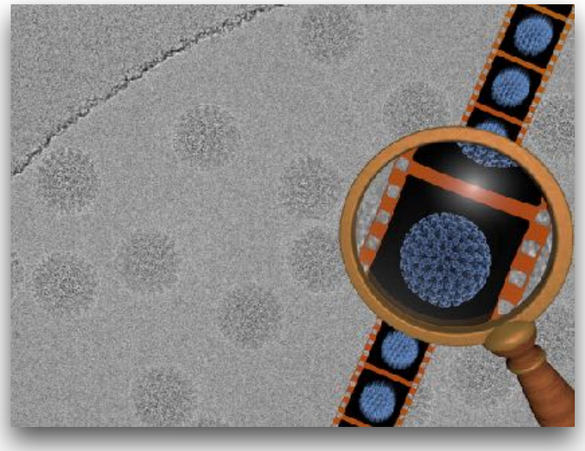


WHAT BROUGHT ABOUT THE RESOLUTION REVOLUTION? (~2012-2014)

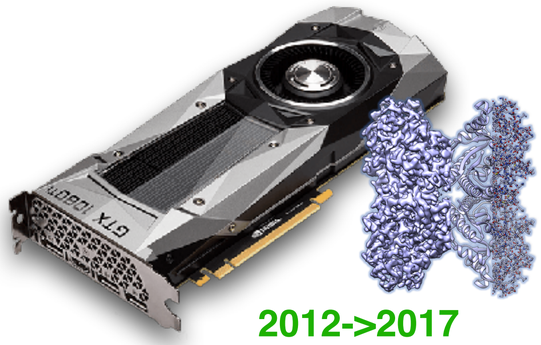
Hardware

Microscopes

Direct Detectors

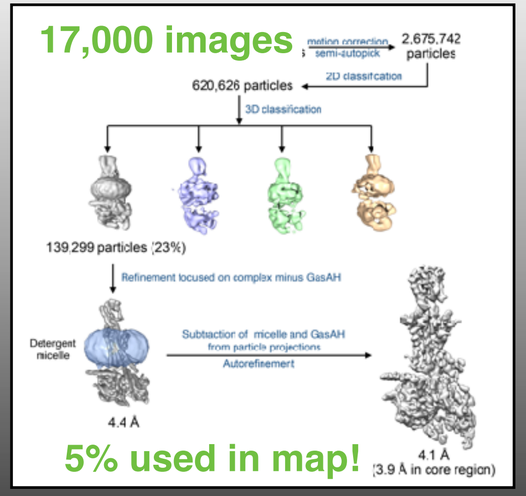


Computers



2012->2017
Cost reduced by 100x

Software

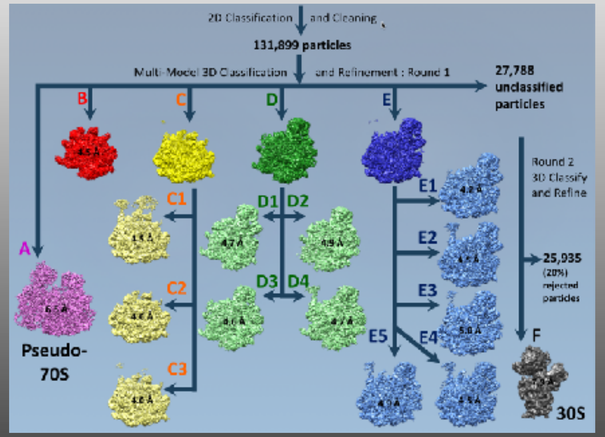


Leginon / SerialEM / EPU, …

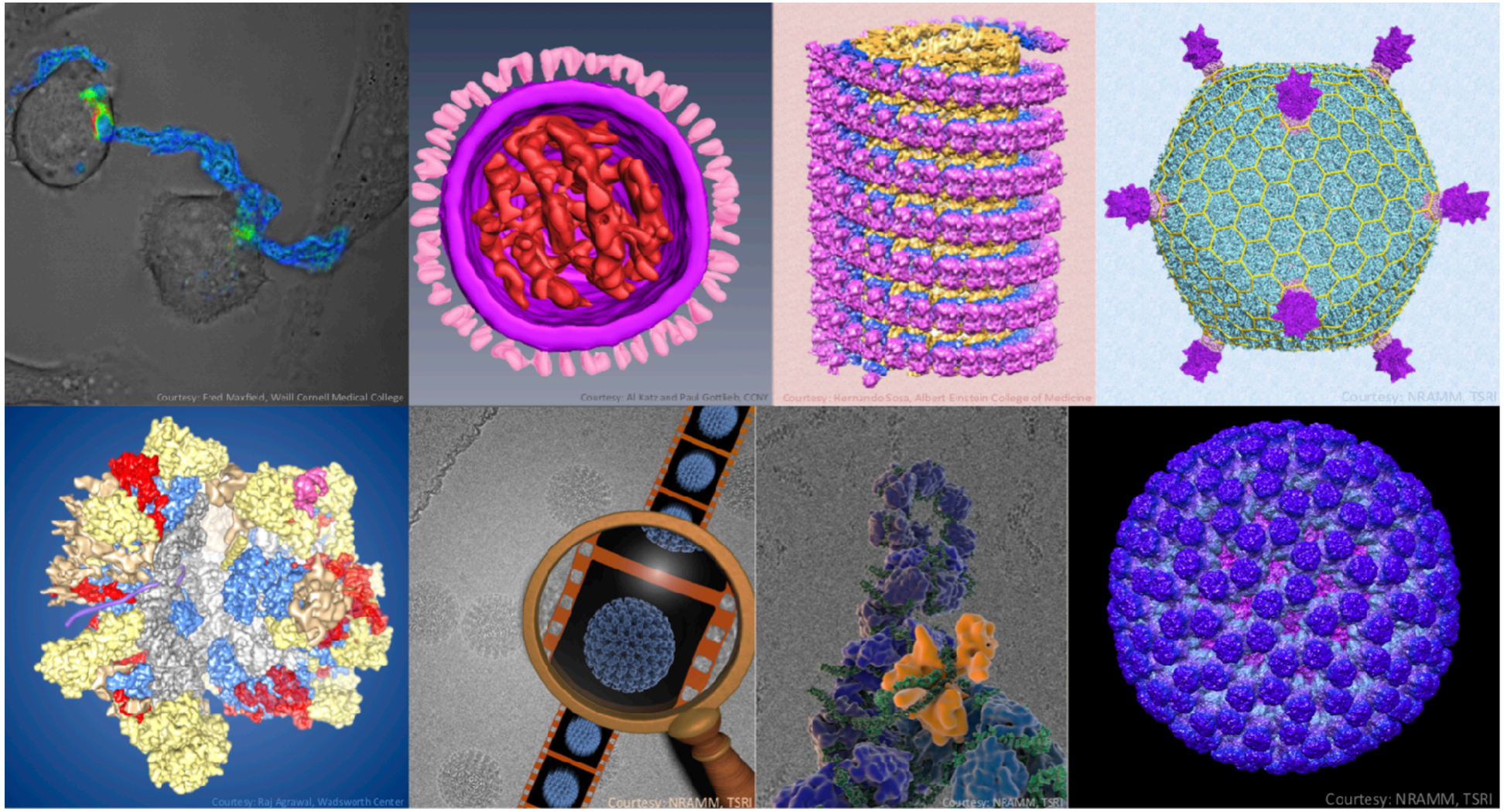
MotionCorr2, Unblur, …

RELION, FREALIGN/cisTEM, cryoSPARC
EMAN, Sparx, SPHIRE, XMIPP, …

14 independent structures



CRYOEM: TECHNOLOGY ON THE RISE



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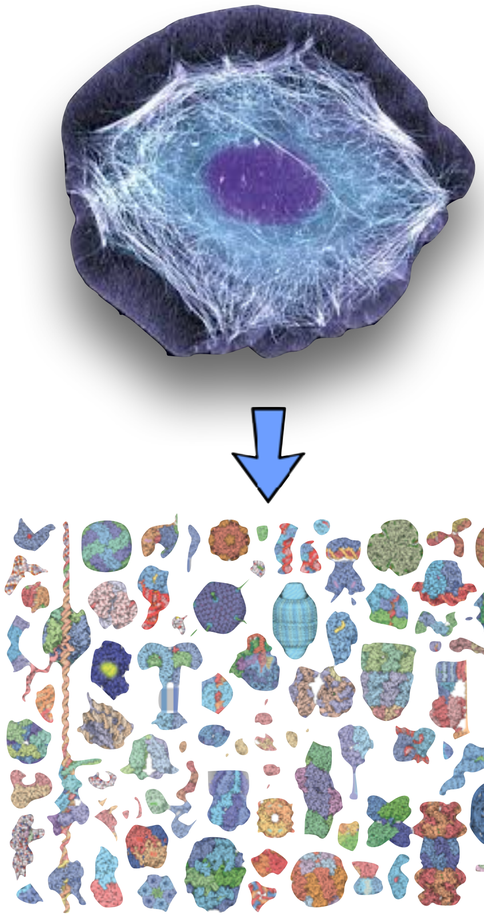
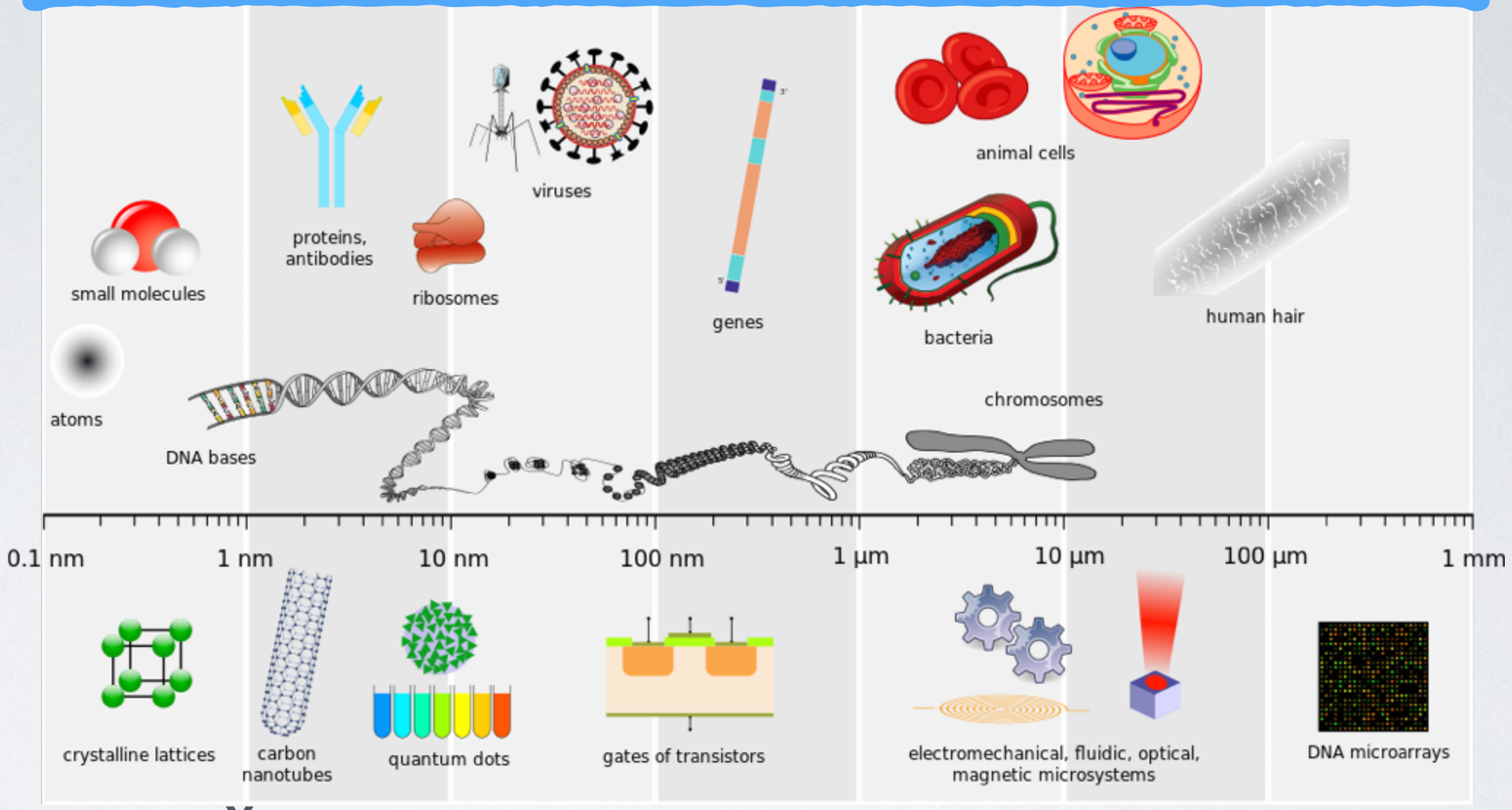


TBD (20??)

CRYOEM: SCALE WITHIN BIOLOGY

Electron Microscopy



https://en.wikipedia.org/wiki/Nanoscopic_scale

X-ray

Naked eye

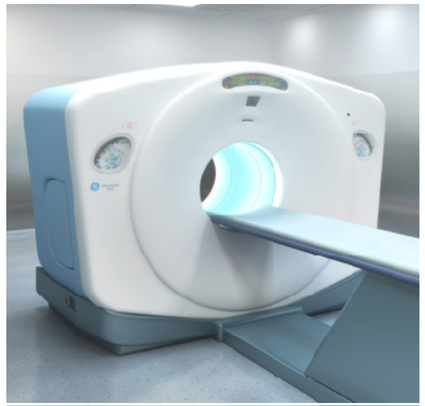
NMR

Light microscopy

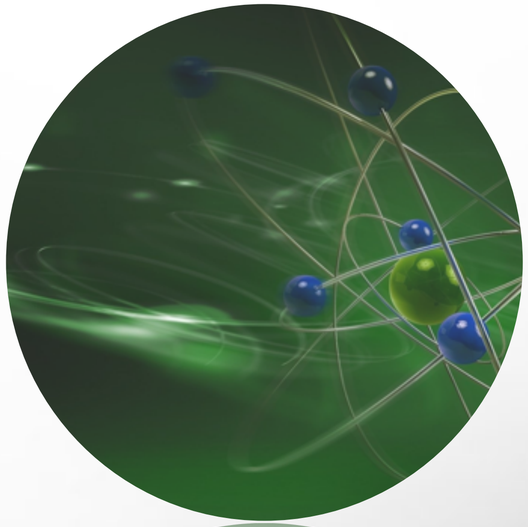
AFM

CRYOEM: MODALITIES | TOOLS

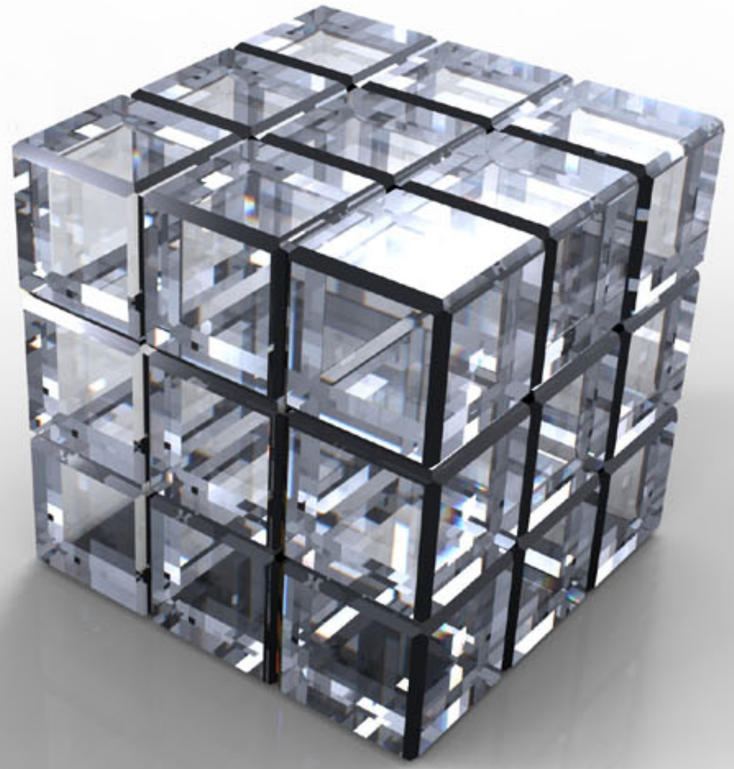
Tomography



Single-particle

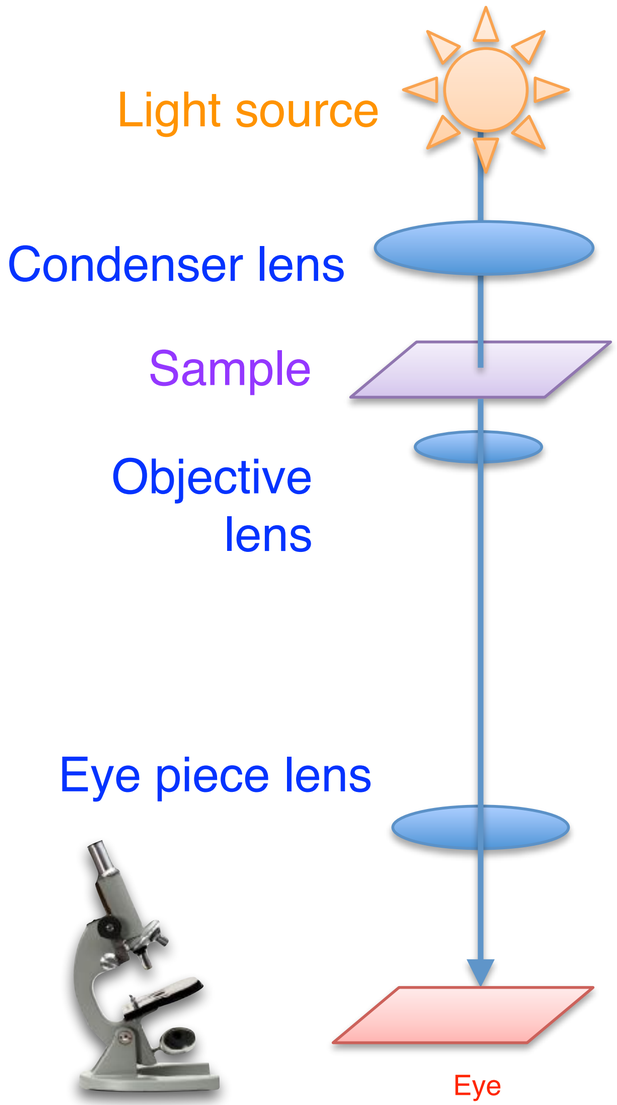


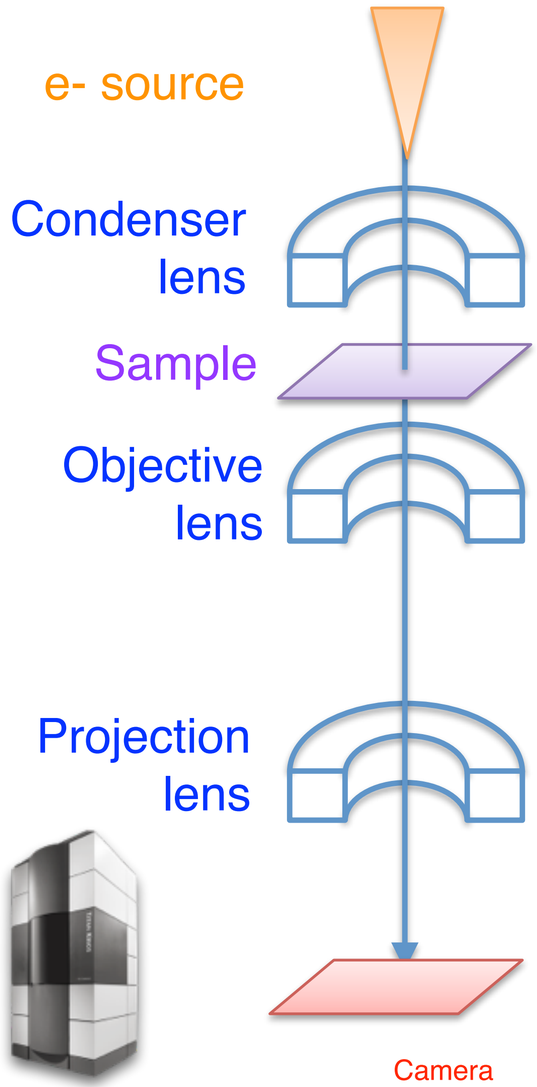
2D arrays

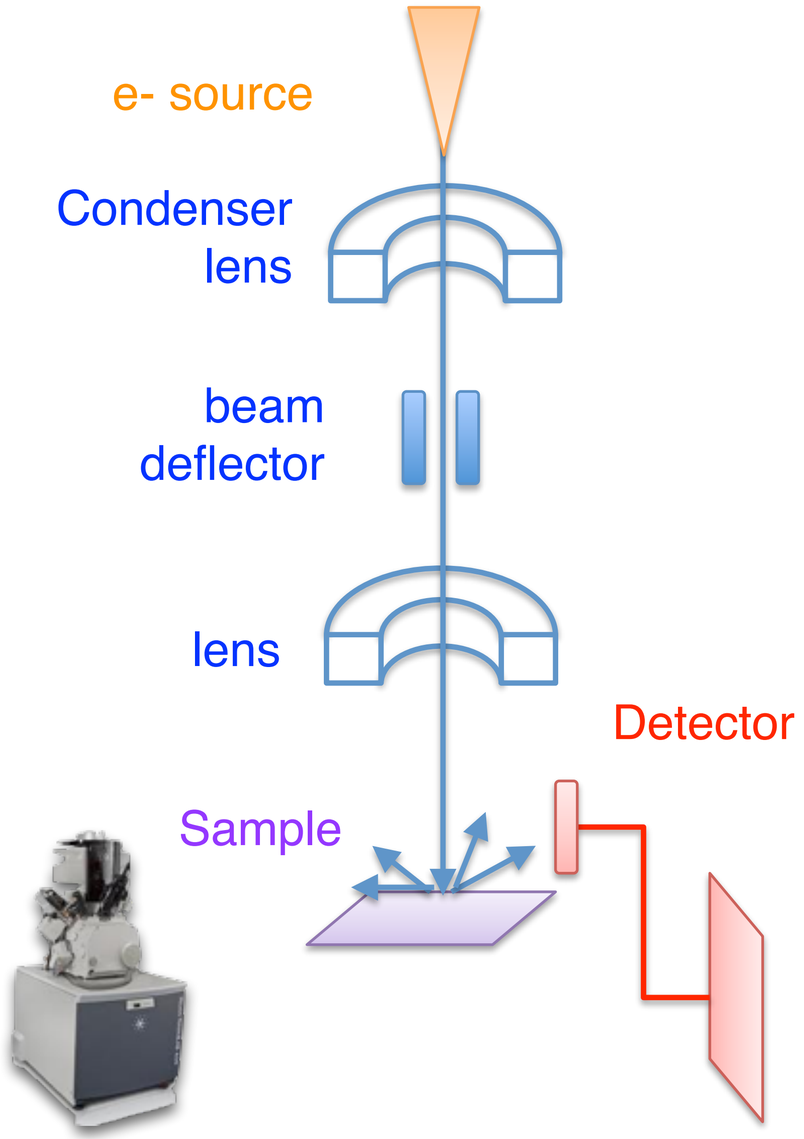


CRYOEM:

TOOLS



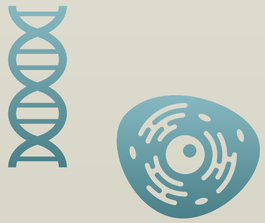




THAT'S GREAT…. HOW DO I START?

THAT'S GREAT…. HOW DO I START?

Core knowledge



Biochemistry & Sample preparation

Data collection

Processing & Data analysis

FOCUS ON 4 AREAS


http://etc.ch/GeHe
START

Welcome to electron microscopy at SEMC

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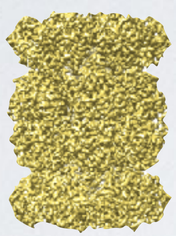
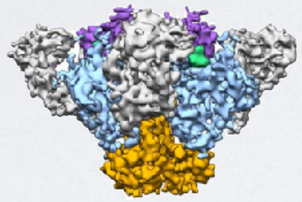
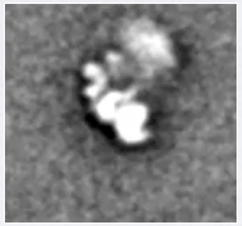
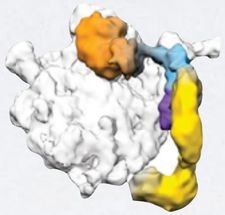
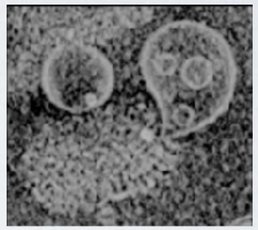
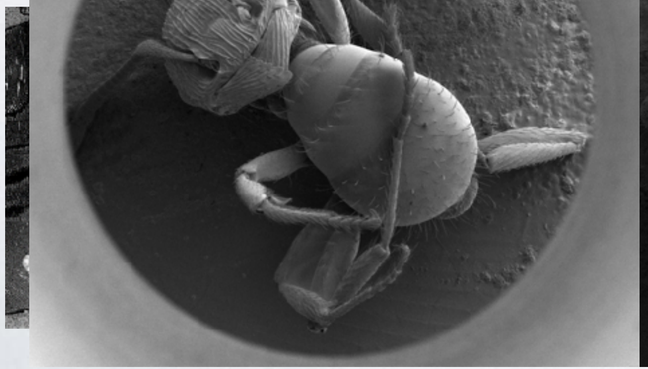
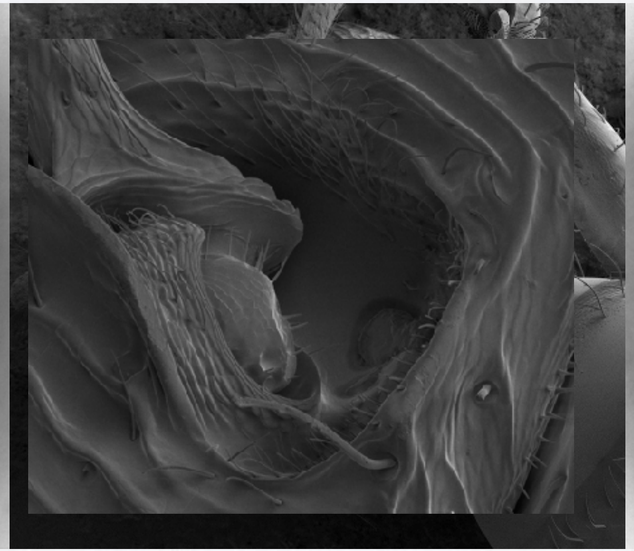
Simons Electron Microscopy Center

Focus on:

Molecular Structure:


Simons Electron Microscopy Center

https://semc.nysbc.org/workshops-and-courses/

yearly	SEMC EM Course	Theory behind EM **Spring semester**
quarterly	SEMC Appion workshop	Appion data processing
monthly	SEMC New User Orientation	Sample preparation Leginon intro/use of screening
	24-hr access test	All hours access test *Safety training*
weekly	User Project Discussion Meetings	Tue @ 3pm *Thurs @3pm /@3:30pm*
daily	Advanced Leginon use	Training for independent use of the microscopes

TRANSFORMATIVE HIGH RESOLUTION CRYO-ELECTRON MICROSCOPY PROGRAM

CryoEM

https://commonfund.nih.gov/CryoEM

The program aims to broaden access to high-resolution cryoelectron microscopy (cryoEM) for biomedical researchers, by creating **national service centers**, and cultivating a skilled workforce, through the development and implementation of **cryoEM training material**.

TRANSFORMATIVE HIGH RESOLUTION CRYO-ELECTRON MICROSCOPY PROGRAM

CryoEM

PACIFIC NORTHWEST Cryo-EM Center

Peter Shen, Janet Iwasa
University of Utah

Ying-Jie Chen, Wen Jiang
Purdue University

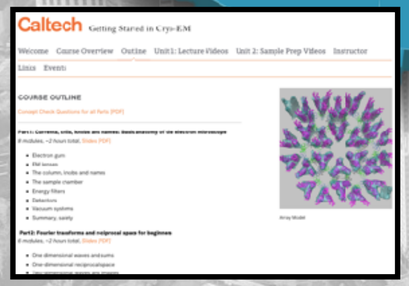
Fred Sigworth
Yale University

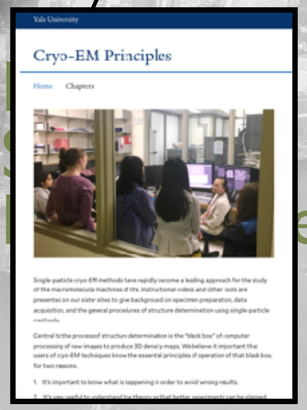
S²C² | Stanford-SLAC Cryo-EM Center

Grant Jensen
California Institute of Technology

NCCAT

NIH





U24 program;
RFA-RM-17-002

photo by Swapnil Bhatkar

National Center for CryoEM Access and Training

NCCAT

General User Proposal (GUP) Access

Cross-Training Proposal (TP) Programs

Apply now

nccat.nysbc.org

@nccatinfo

MAKING CRYOEM MORE ACCESSIBLE TO THE COMMUNITY

NYSBC
SEMC
NRAMM
NCCAT

Directors


Bridget Carragher


Clint Potter

Administrators


Cathleen Castello


Elina Kopylov

Scientific computing/programmers


Anchi Cheng


Sargis Dallakyan


Shaker Krit


Swapnil Bhatkar

Facility and microscope operations


Ashleigh Raczkowski


Laura Yen


Misha Kopylov


Daija Bobe


Carolina Hernandez


Robert Gheorghita


Mahaira Agaron


Kashyap Maruthi


Huihui Kuang


Anjelique Sawh


Michael Alink

Technology research


Venkat Dandey


Alex Wei


Alex Noble


Chase Budell

Structural biology research


Julia Brasch


Jason Gorman


Micah Rapp

...and me!

NIH P41 - National Biomedical Technology Research Resources (BTRR)


Krios1


Krios2


Krios3


Krios4


Krios5


Krios6

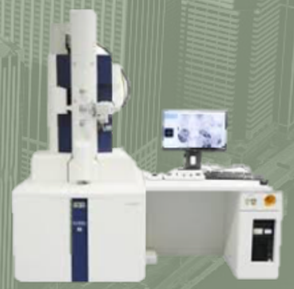

Krios7
2020


Tecnai F20


Tecnai12


JEOL1230


Helios650


Hitachi 7800


Glacios
2020

Chameleon

Simons Electron Microscopy Center

Tour