

M3D1:Growth of phage materials







11/13/15

- ✓ 1. Purify M13 bacteriophage (phage)
- ✓ 2. Prelab during 60min incubation
- ✓ 3. Finish M13 purification and prep iron solution
4. Measure concentration of M13 phage
5. Complex phage with Ammonium iron II sulfate hexahydrate, $(\text{NH}_4)_2\text{Fe}(\text{SO}_4)_2$

Lab business

- Office hours
 - Noreen: Fri 6:30-8:30p in 56-302
- M3 major assignments
 - Research proposal (20%)
 - Most M3 homework preps for this
 - Mini-report (5%)
- Don't forget to blog!!

We are in the homestretch...

3	1	R/F Nov 12/13	AB 	Growth of phage materials	Homework due Protein engineering report due Sun, Nov 15 at 5 pm
3	2	T/W Nov 17/18	AB 	Purify active materials	Homework due
3	3	R/F Nov 19/20	AB 	Cathode construction	Lab quiz Homework due
		T/W Nov 24/25	AB 	Lecture as scheduled, but no lab!	
		R/F Nov 26/27		Thanksgiving holiday	
3	4	T/W Dec 1/2	AB 	TEM	Homework due
3	5	R/F Dec 3/4	AB 	Battery assembly and testing	Lab quiz Homework due Biomaterials engineering mini-report due Thu/Fri, Dec 3/4 at 10 pm
3	6	T/W Dec 8/9		Research proposal presentations	Research proposal presentation slides due Tue/Wed, Dec 8/9 at 1 pm
		R Dec 10		Feedback and celebratory lunch!!!	

Mod 3 overview

1. Purify M13 phage
2. Generate Fe(III)-phage nanowires
3. Construct cathode
4. Visualize nanowires using TEM
5. Build Li-ion battery
6. Measure capacity

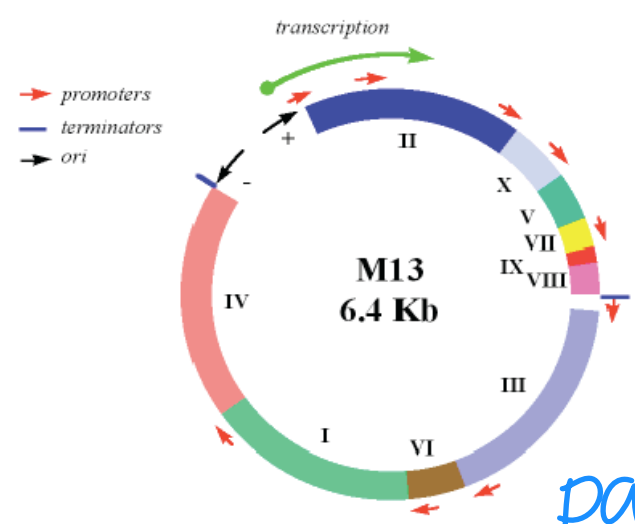
Your experimental question:

How does phage quantity effect battery capacity?

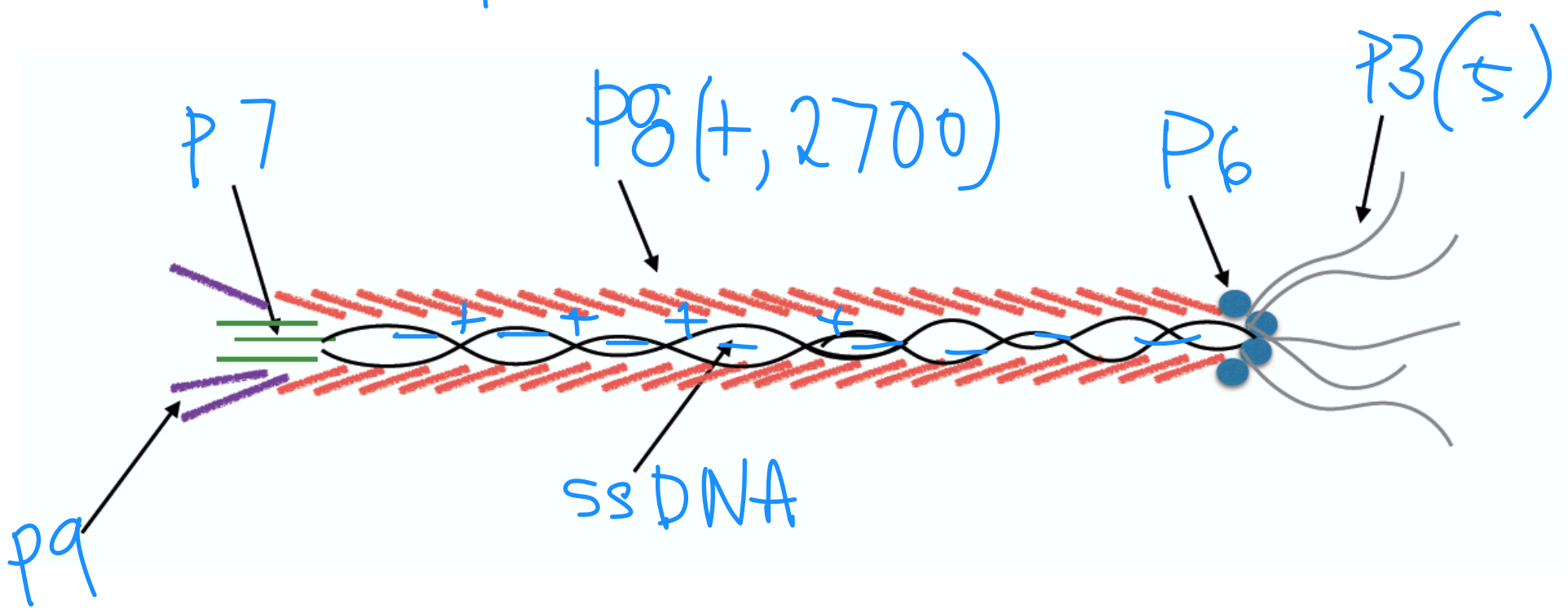
DNA, packaging proteins, replication proteins

M13 phage genetics and structure

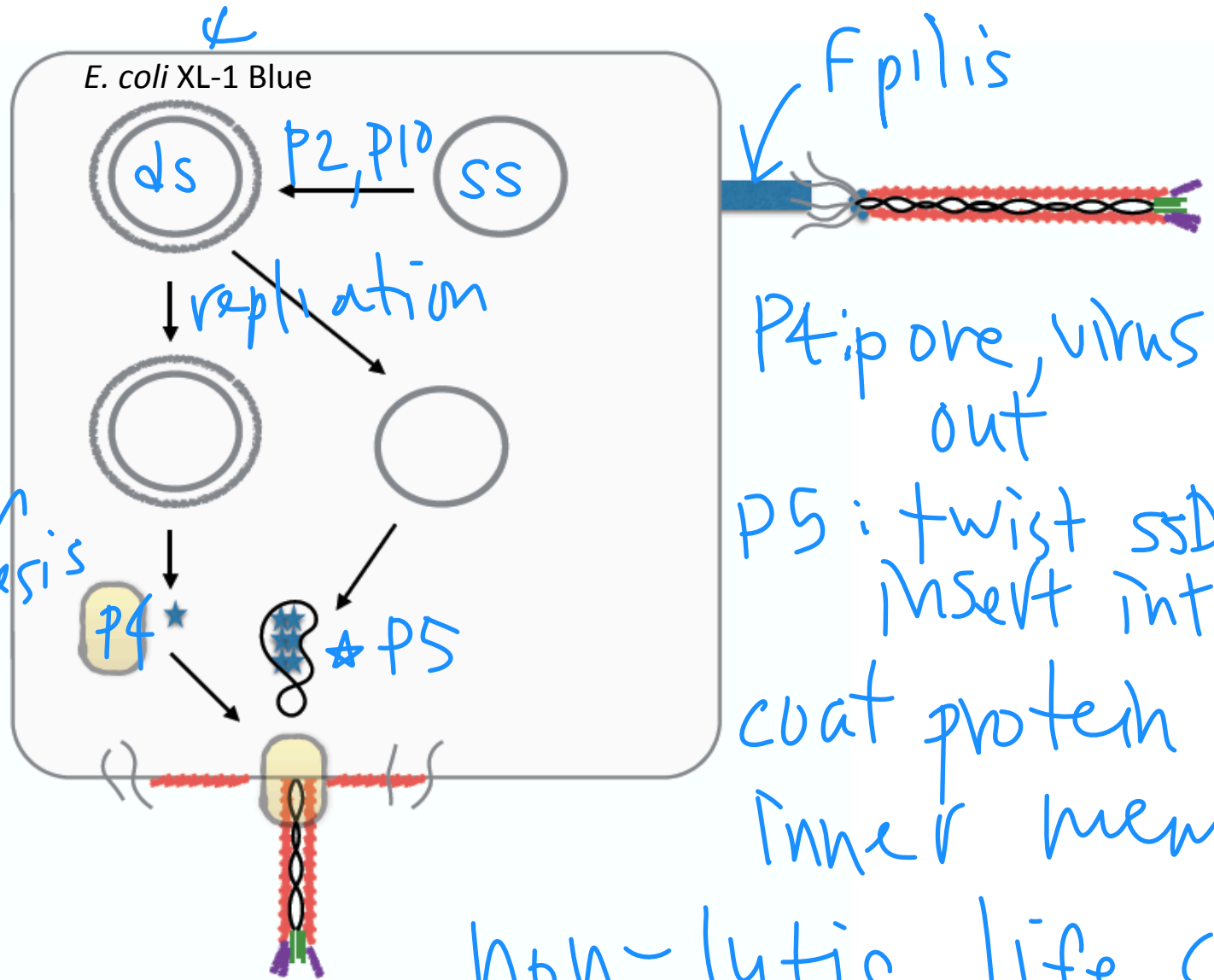
900 nm long, 6 nm thin



packaging = coat = capsid



Overview of M13 phage biology



protein synthesis

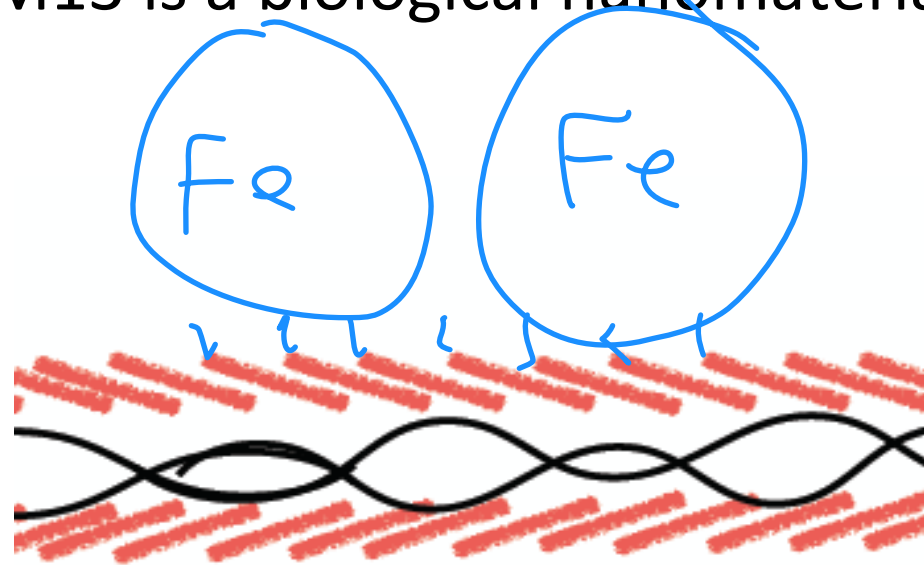
P4 pore, virus pushed out

P5: twist ssDNA, insert into coat

coat protein in inner membrane

non-lytic life cycle

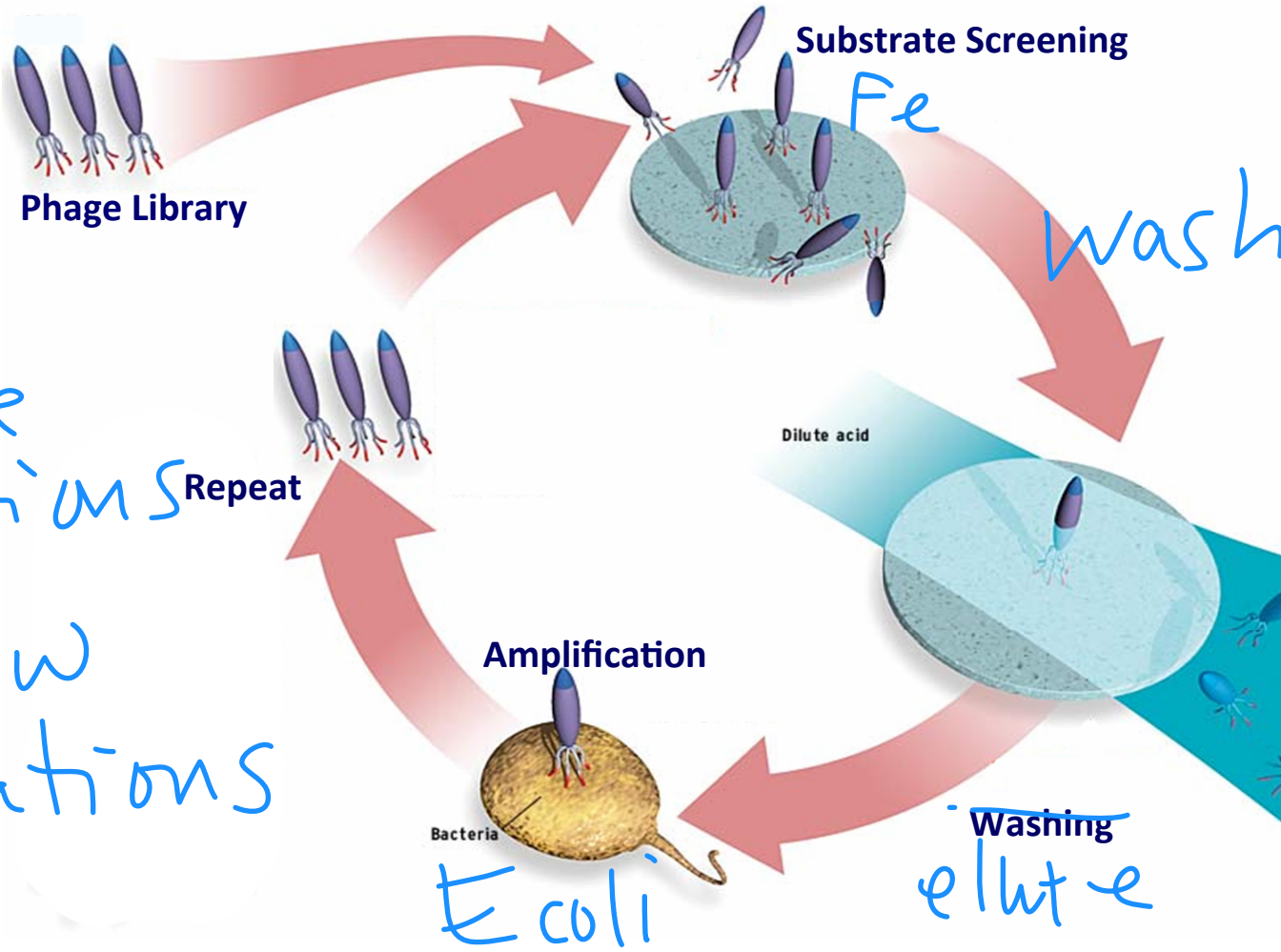
M13 is a biological nanomaterial



- p8 coat protein mutated to contain sequence DSPHTELP
- Modified p8 proteins bind single wall carbon nanotubes (SWCNT) and iron

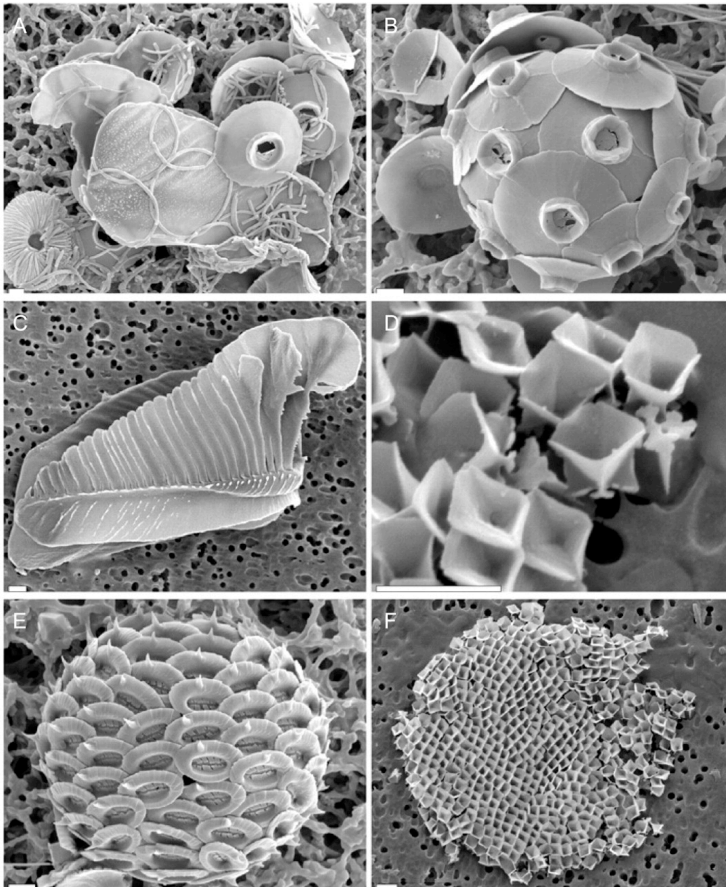
p2 - 2700 copies, 4-6 neutral/neg AA
Overview of phage display

p3 - 5 copies, 20-30 AA



Iterational design, directed evolution

M13 phage and biomineralization



Diatoms

- Environmental conditions

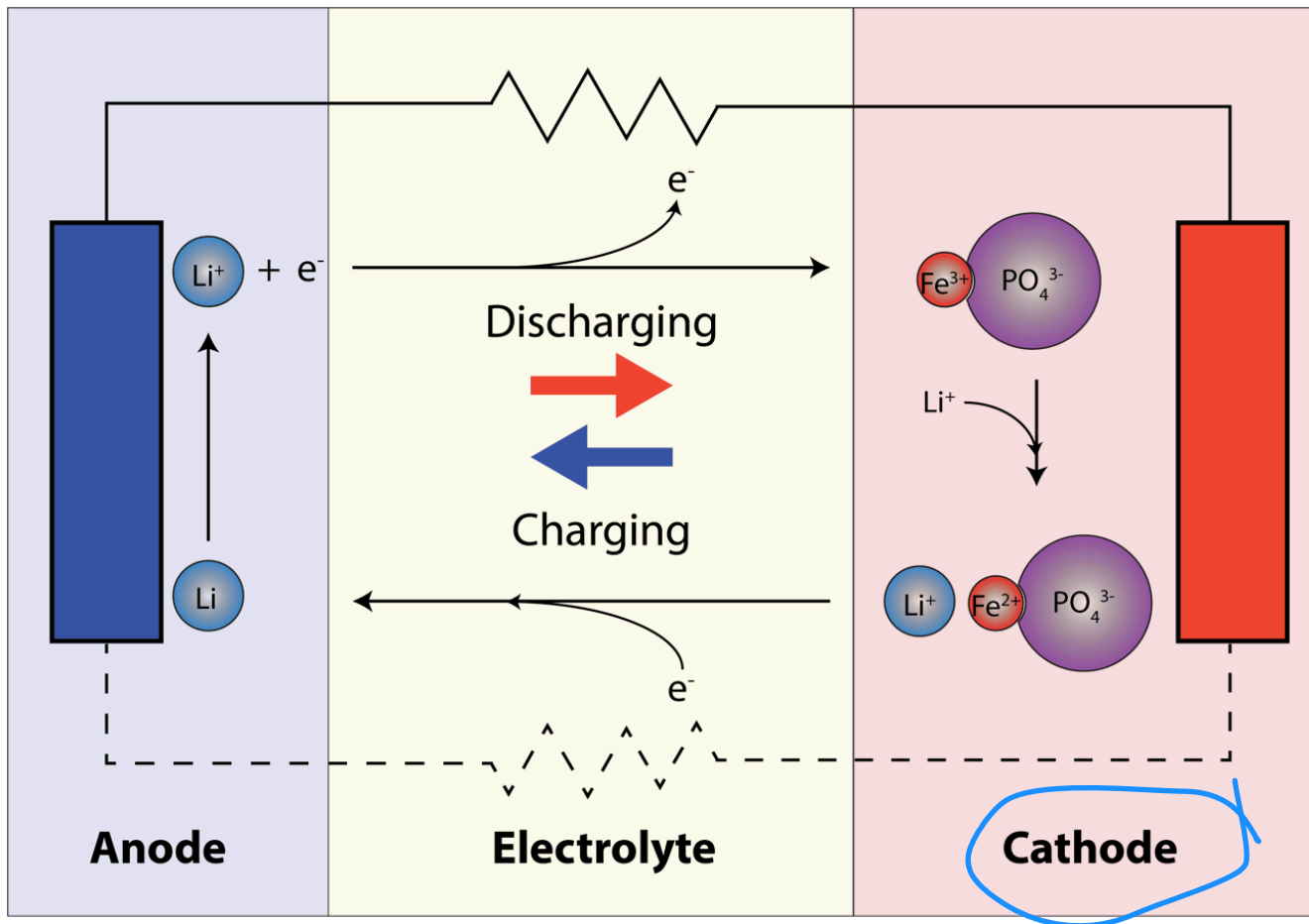
4°C, buffer/H₂O

- Organization

align Fe along
900 nm length

- M13 provides scaffold for Na(FePO₄) cathode construction

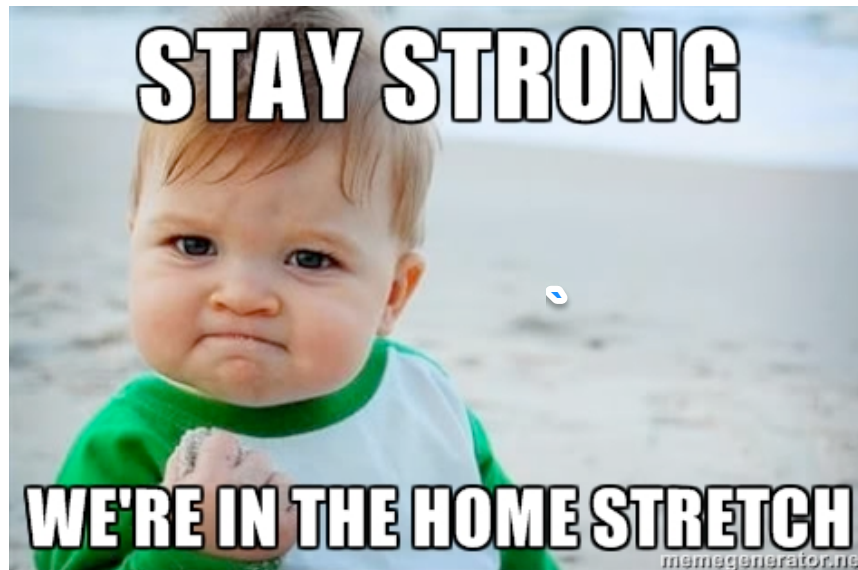
M13 nanowires as battery cathode



Thank you, George!

Today in lab...

- Finish phage purification
- Calculate phage number
- Begin Fe(III)-phage biomineralization



extinction
coefficient

$$\# \text{ phage} = \frac{\left(6 \times 10^{16}\right) \left(\overset{\text{measured}}{A_{269} - A_{320}}\right)}{\# \text{ bases in genome}}$$

bases in genome

[7220]

account for dilution