

Teaching and Learning in Science Labs

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Tomlinson Project in University-Level
Science Education

- Tomlinson Project in University-level Science Education
www.mcgill.ca/tpulse
- Run Fall and Winter workshops:
 - The Graduate Teaching Workshop
 - The Teaching Techniques for Instructors Workshop
- Undergraduate programs
 - The Tomlinson Engagement Award for Mentoring (TEAM)
- Resource for TAs
- Research in science education

Have you taught a science lab before?

- 1. No, never**
- 2. Yes, once**
- 3. Yes, > once**

What do you hope to learn from this workshop?

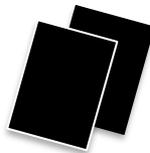
- 1. How to manage and get what you expect from a lab-full of students**
- 2. How to prepare for and execute labs in the best and most efficient way**
- 3. How to maximize student learning in a lab setting**

Learning Objectives

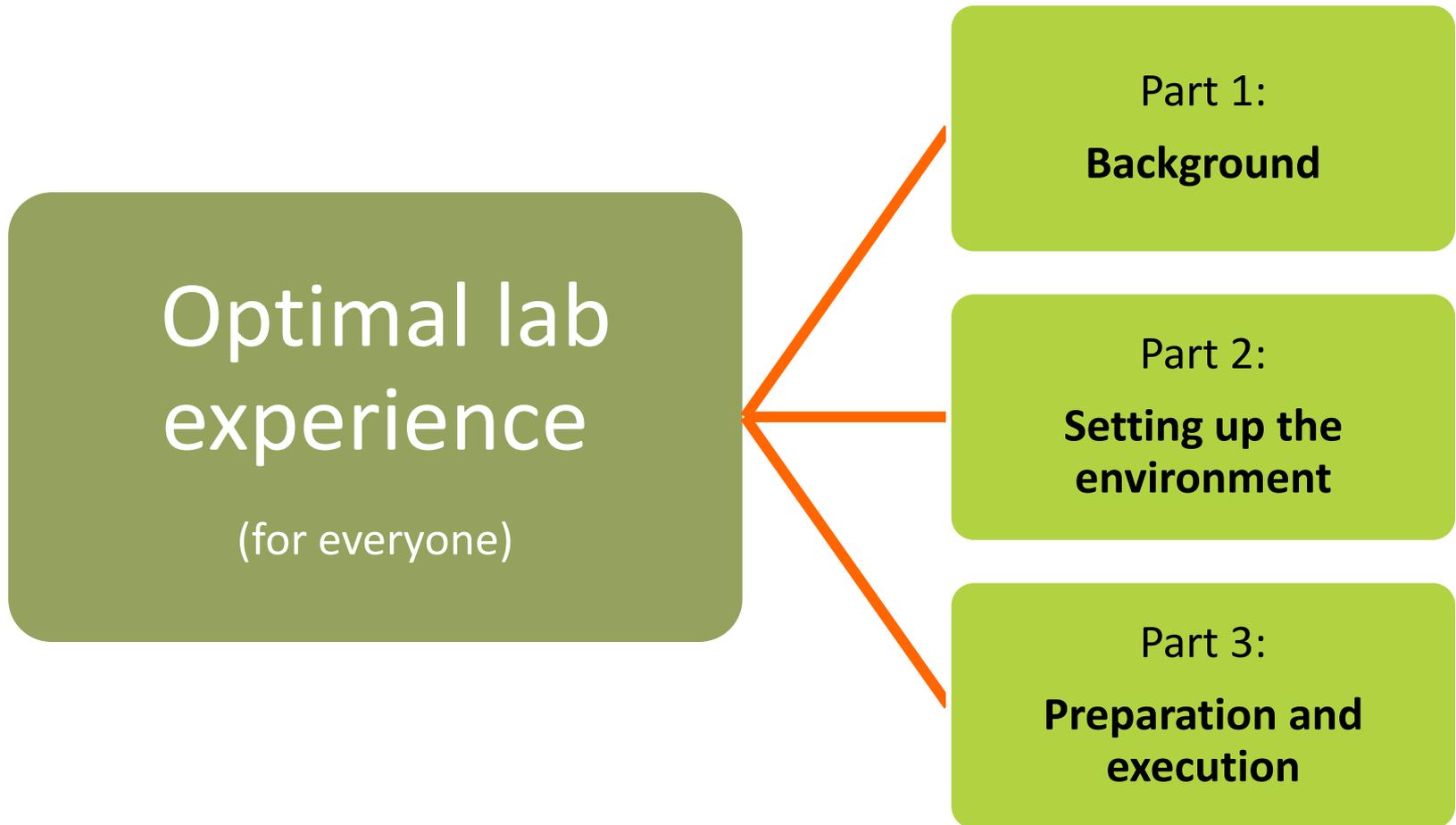
By the end of this workshop you should be able to:

- 1. *Recognize*** how students learn to maximize teaching
- 2. *Understand*** how to set up a safe, clean, and interactive environment that is conducive to student learning
- 3. *Identify*** how to effectively prepare to teach and facilitate undergraduate science labs

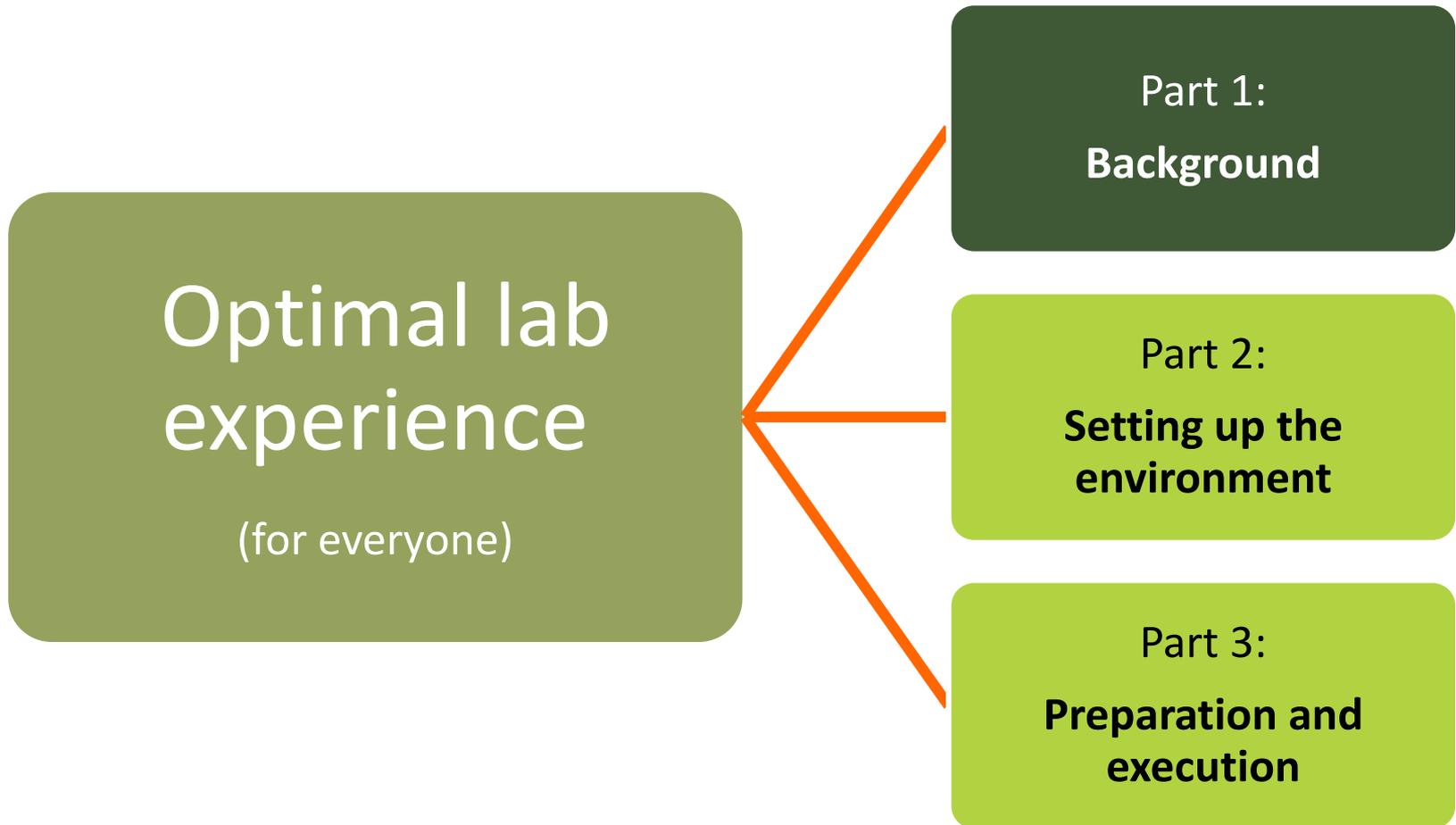
Go to your handouts when you
see this symbol:



Overview



Overview



Different Viewpoints

- **Students**
 - Don't want to do unnecessary work.
 - Want to learn new things and enjoy themselves.
- **TAs (you!)**
 - Want the lab to run smoothly.
 - Want the students to learn new things.
- **Lab Techs**
 - Want the lab to run smoothly.
 - Want to not have to clean everything up afterwards.

The Value of Labs

- Small class sizes (unlike lectures)
- Interactive sessions
- Hands-on reinforcement of things taught in lecture



Learning Vocabulary

- **Passive Learning:**

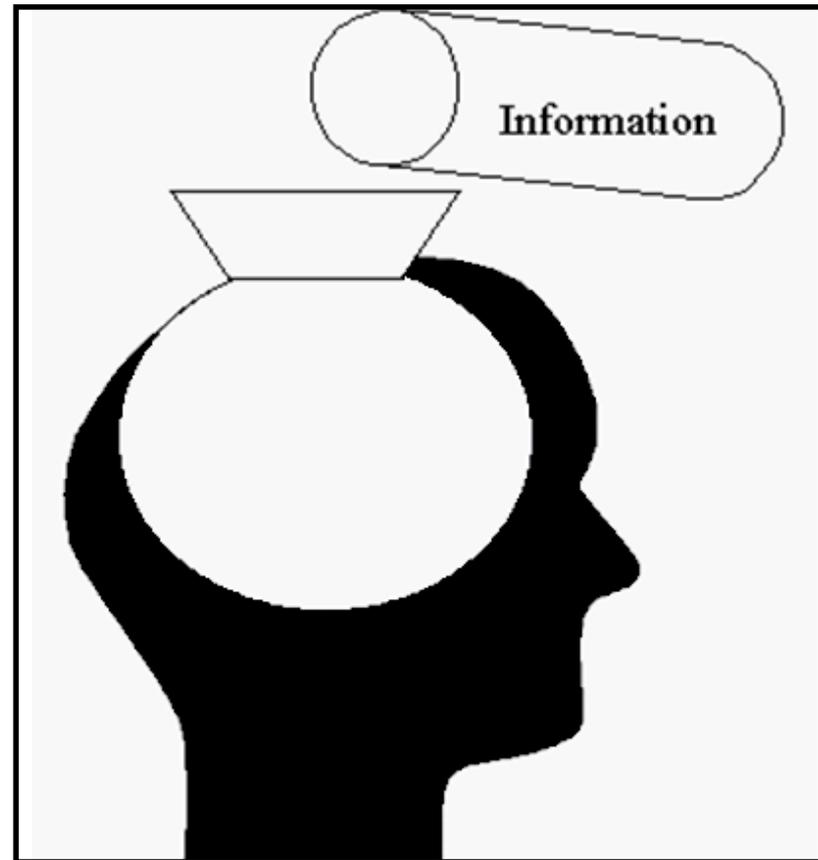
- reading, hearing, seeing and transcribing: Learning facts
- Shallow engagement with the material

- **Active learning:**

- learning from life experiences, teaching, writing (synthesizing), asking questions: Understanding concepts/ideas
- Deep engagement with the material

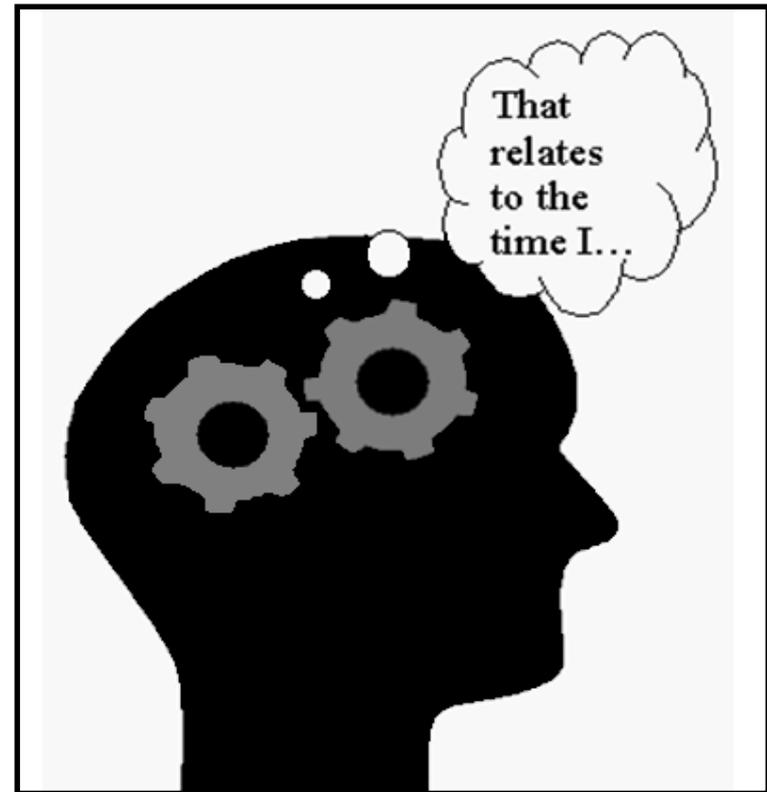
Passive Learning: Basic Principles

- Knowledge is static and exists outside the individual – no personal affiliation
- Learning is memorization
- Teaching is a flow of information from educator to learner



Active Learning: Basic Principles

- Knowledge is constructed by integrating new information; a personal understanding
- Teaching: builds on prior background, work with the content to construct a meaning for the student



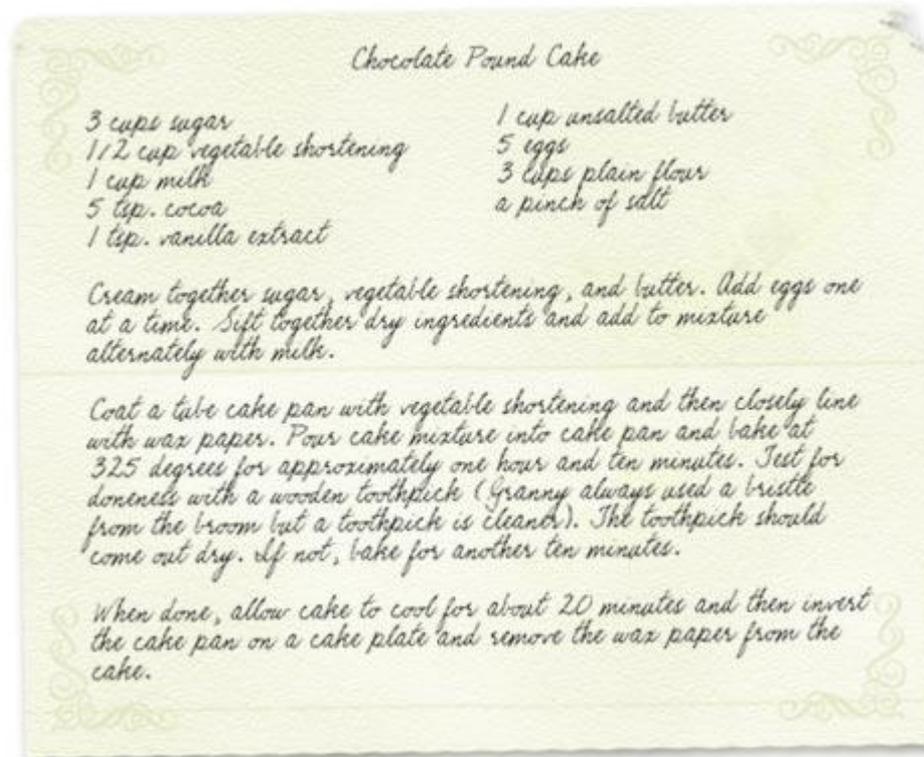
Labs and Active Learning

Labs are a well-crafted forum for active learning but it's not a given

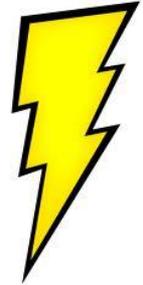


Labs and Active Learning

Cookbook-style labs are not active learning



Peer Learning



- Get students used to the idea of using each other as resources
- Ask successful lab groups to demonstrate how and what they did to the rest of the group
- Positive reinforcement, effective learning, and minimal effort = a powerful method!

Think-Pair-Share



- Ask a question, let the students think about it
- Then get the students to talk to one another and share their ideas

Pairing up helps with confidence

- Have a class discussion to bring these ideas to the rest of the class

Active Learning Strategies

Ask yourself

Students ask themselves questions before starting. Eg: What will be the hardest part of this lab?

Paraphrasing

Students rephrase in their own words what they are learning

Jigsaw Teamwork

Each student familiarizes themselves and is an expert in one section and then each of them teach their section to the others in their group.

Learning Cell

Pair students in groups of two and have them alternatively ask and answer questions regarding lab and material.

Background Knowledge Probe

Ask students questions with basic, simple responses to ascertain their knowledge.

Brainstorm

Ask students to brainstorm what the experimental procedure should be.

Facilitating Active Learning

ACTIVITY: Individually 5-10 min

- Think of the lab course you are teaching, or one you took during your undergrad.
- Find a scenario in which you would implement an active learning strategy during that lab.
- Describe this scenario and how you guide the active learning.



Active Learning Strategies

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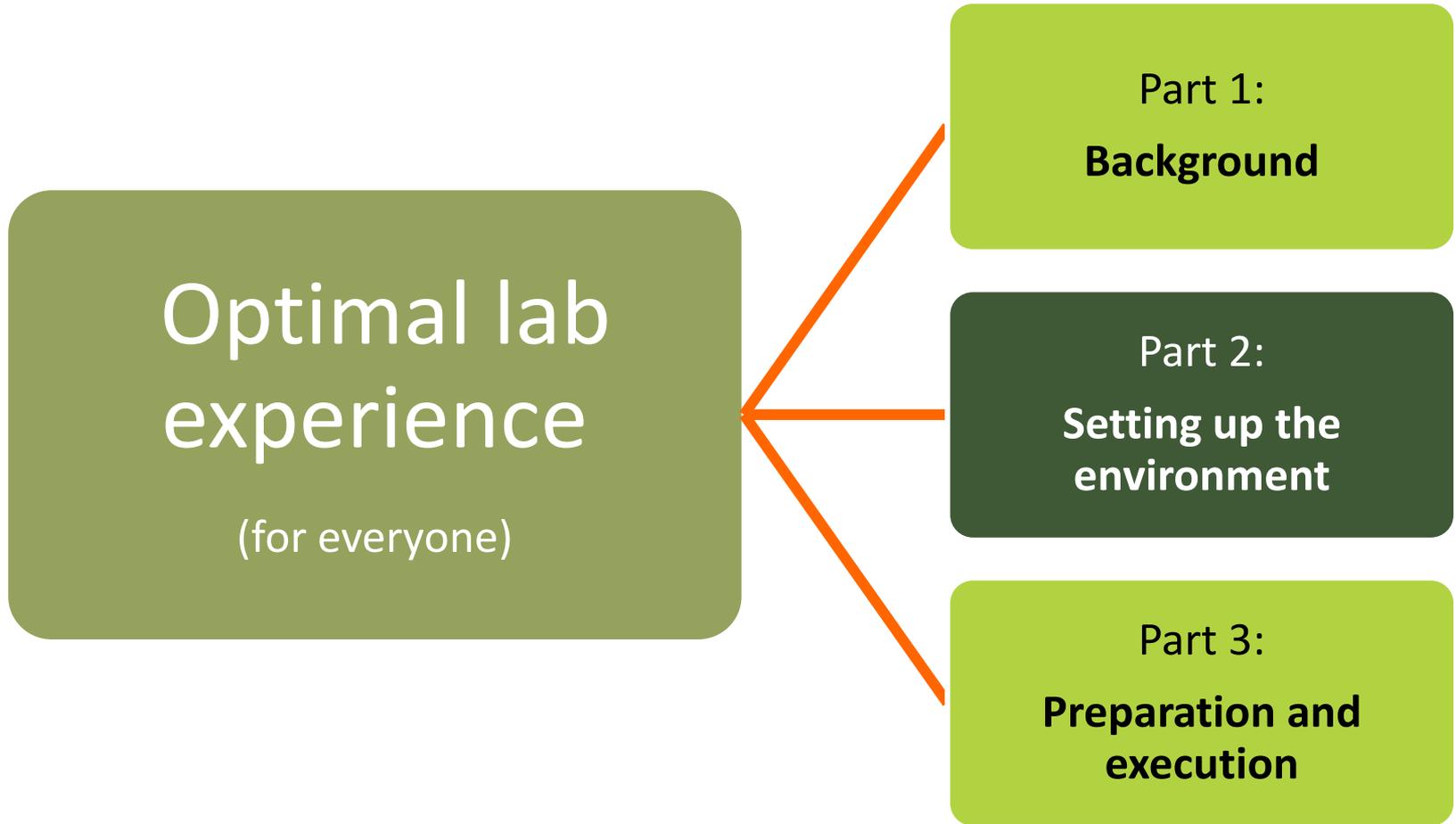
Ask students to brainstorm what the experimental procedure should be.

Facilitating Active Learning

ACTIVITY: In a group 5-10 min

- Share the details of your lab course with the person next to you
- Describe how you would implement your active strategy?
- Does it get students to engage with each other and with the lab concepts?

Overview



About Undergraduates

- Be understanding, patient, available
- Remember what it's like
 - Stress, being on your own for the first time
- Student diversity
 - Students come from all sorts of backgrounds, cultures, schools

Expectations

- Start right away and be consistent
 - Using a marking scheme
- Stick to deadlines
 - have a late policy
- Lab Benches
 - Standards before leaving
- Behaviour – expectations and consequences

Plagiarism

- **McGill Policy: Do not accuse the student**
 - “If you are a teaching assistant, you should report the incident to the course instructor, who should report it to the disciplinary officer”
- **Prevention is possible**
 - Be vocal about how plagiarism hinders learning

Getting to Know Each Other

- It should start on the first day
- Let them know you
 - Personal stories, your research projects, etc.
- Get to know your lab group
 - Taking attendance – a great way to learn their names
 - Make notes about them for yourself only

Introduction Cards

- A simple way to learn more about the members of your class
- Can help tailor the content of your teaching
- Fill one out with your information as a sample!

Sample Introduction Card A

Major: *undecided.*

Hometown: *Richmond Hill*

Languages spoken: *English.*

Educational Goals:

Interests:

Dream Job:

Sample Introduction Card B

Major: ? (Pharmacology, Chemistry?)

Hometown: Mississauga, Ontario

Languages spoken: English

Educational Goals: Probably grad (med school).

Interests: A PhD would be great ☺
Choir, classical music/singing,

Dream Job: Skiing

Introduction Card Intense researcher person,
Pharmacologist

Sample Introduction Card C

Major: BIOCHEM

Hometown: CALGARY

Languages spoken: ENGLISH, FRENCH, MANDARIN

Educational Goals: Finish a 4 year degree in 3.

Interests: cross country running, swimming, classical lit.

Dream Job: Prof, biochemistry

Designing Intro Cards



ACTIVITY: Individually 5 min

- Build your own intro card with questions you will ask to your students.
- Think of 4-5 questions
- Make sure each question is valuable and helps you get to know your students



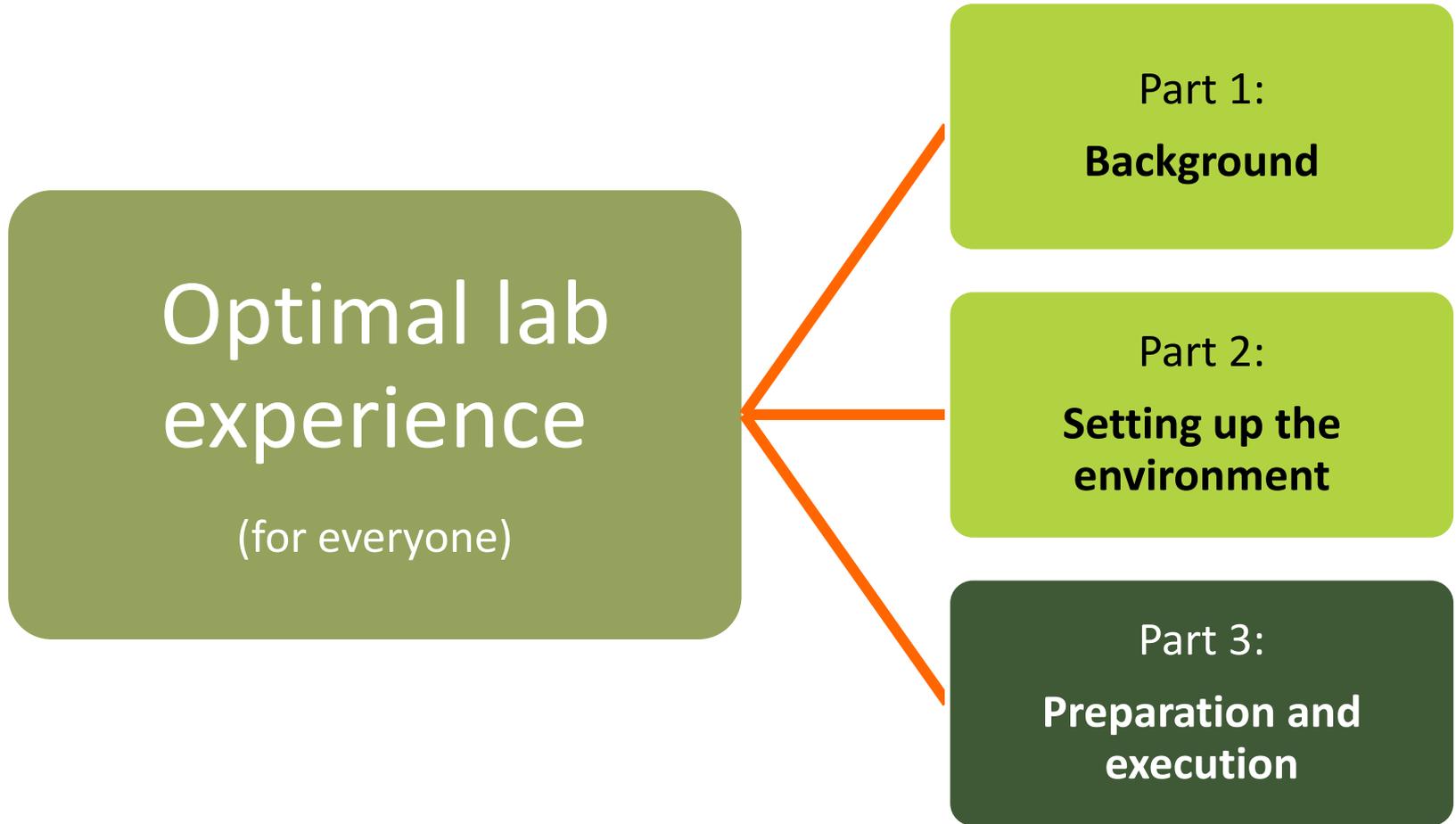
Designing Intro Cards



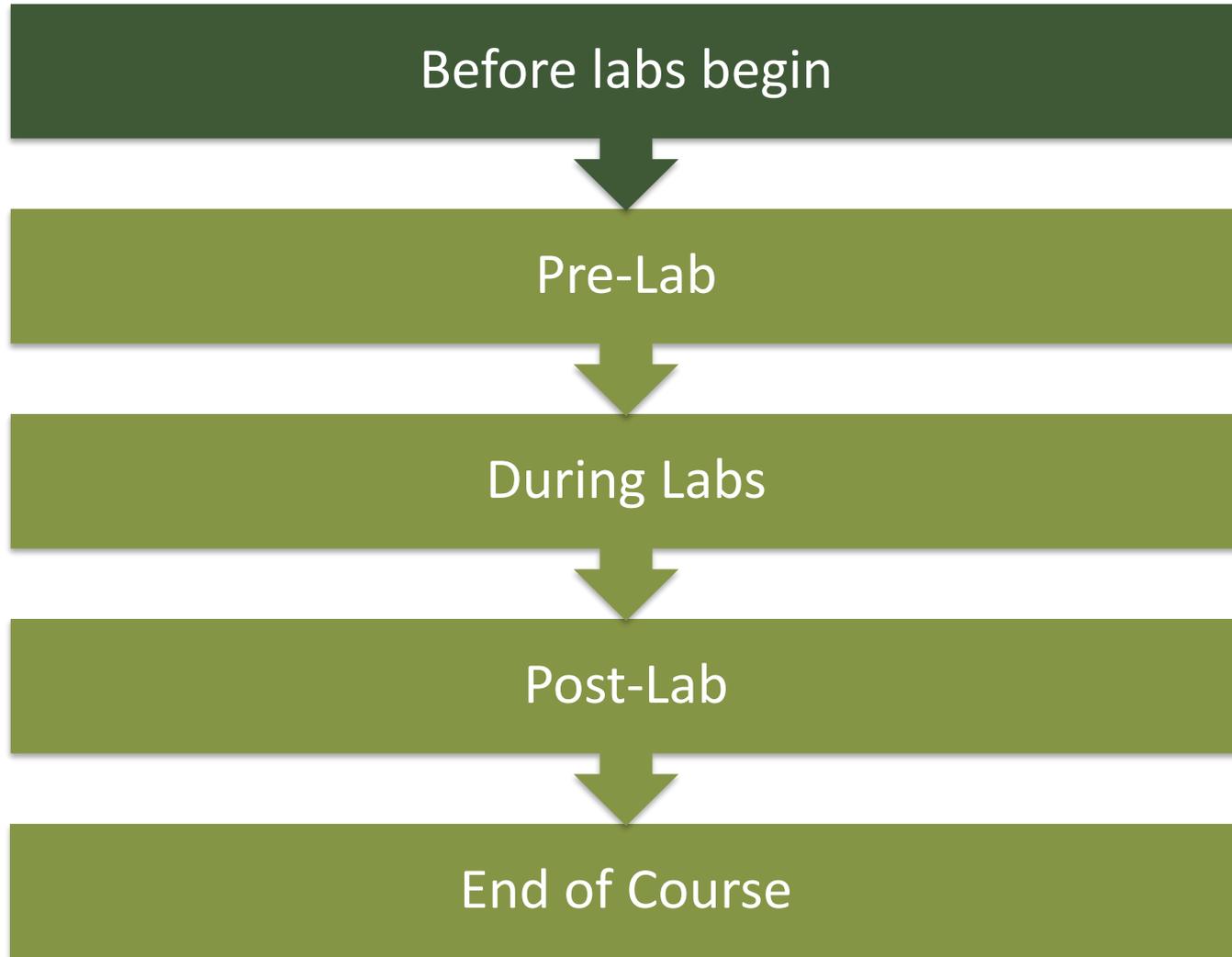
ACTIVITY: In a group 5 min

- Share your introduction card with your neighbour
- What were some interesting questions that came up?
- Why did you choose these questions?

Overview



Semester Timeline



Before labs
begin

Meet other instructors

- Meet with lab supervisor and other TAs
 - Expectations of lab sessions
 - Consistency in running labs, marking
 - Check out the lab manual
 - Schedule prep sessions to go over labs
 - Hours breakdown

Before labs
begin

Course Material

- Keep track of how labs relate to what students are learning in lecture
 - Best way – attend lectures
 - Other ways – skim course outline/lecture notes and look up materials in textbook, ask students

Before labs
begin

Safety



Compressed
Gas



Flammable



Oxidizer



Poisonous



Toxic



Biohazard



Corrosive



Reactive

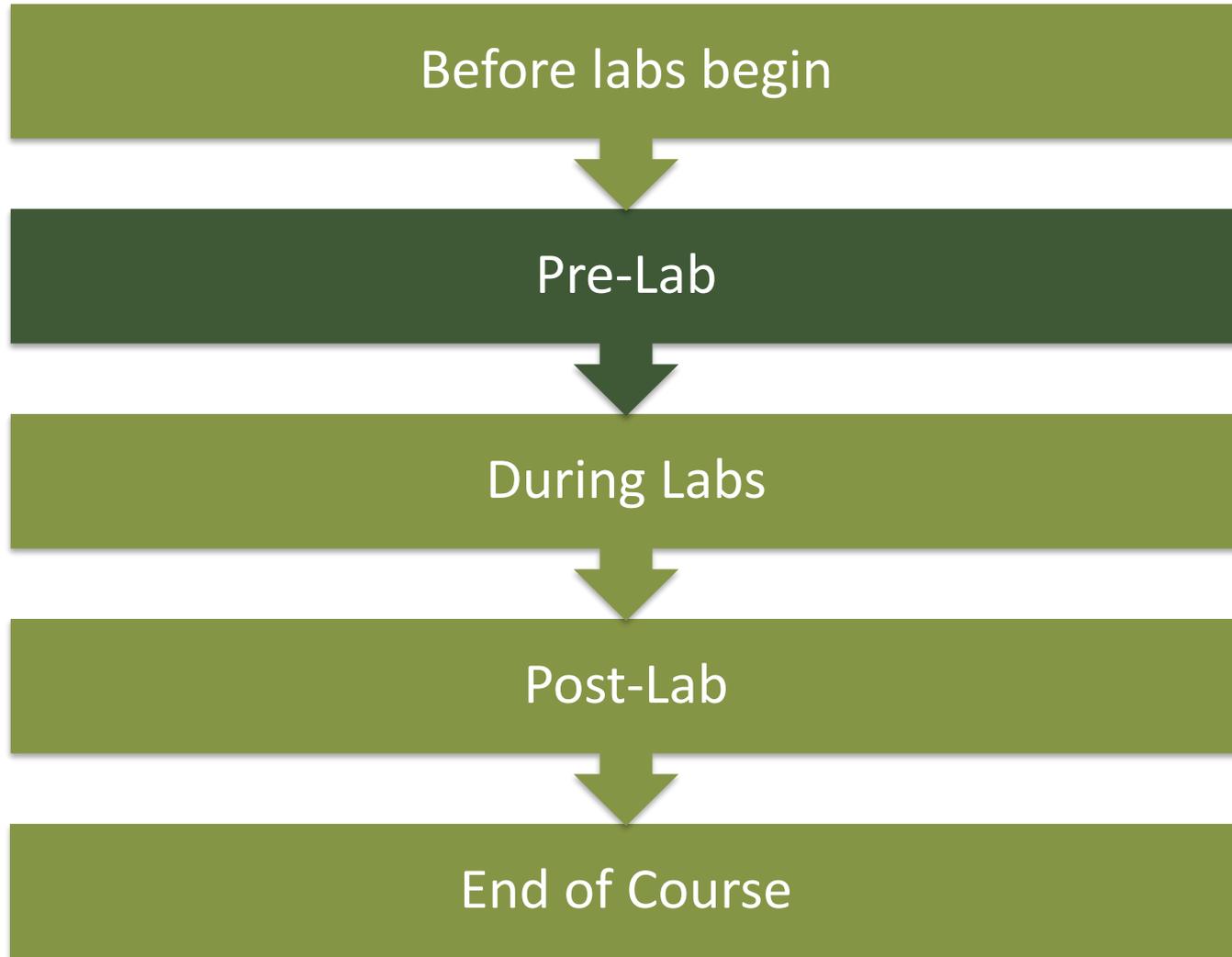
- Departmental safety courses a must!
- Be familiar with:
 - WHMIS and MSDS/MyLab
 - Specific rules for the lab
 - How to report accidents
 - First aid kit and emergency exit
- Environmental Health and Safety (EHS)
 - mcgill.ca/ehs/
- Be a role model!

TA Housekeeping

- Make sure to keep track of your hours!
- Balancing research and TA time

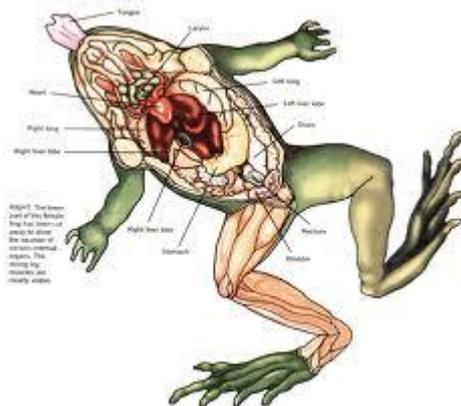
	Monday	Tuesday	Wednesday	Thursday	Friday
9:00 – 10:00					
10:00 – 11:00	TA Briefing				
11:00 – 12:00					
12:00 – 1:00			108 Lab Prep Time		
1:00 – 2:00		108 Lab Prep Time			
2:00 – 3:00				108 Prep Time	
3:00 – 4:00			Bio 108 LAB	Bio 108 LAB	
4:00 – 5:00					
5:00- 6:00			Clean-up and Questions	Clean-up and Questions	

Semester Timeline



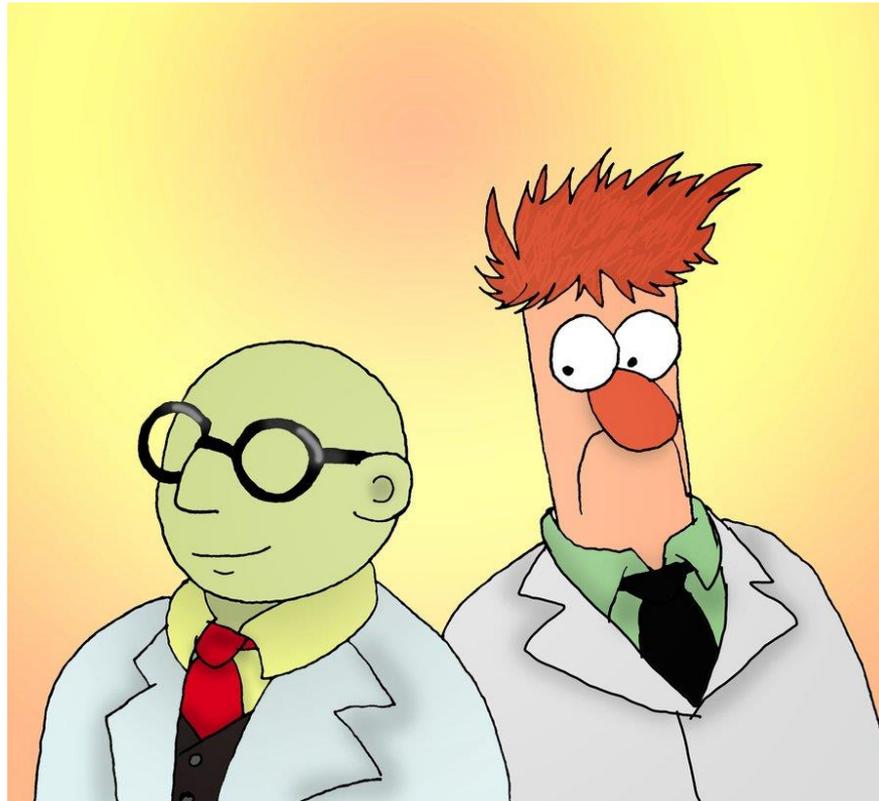
Preparation

- Use TA briefing time fully!
 - Discuss lab with more experienced TAs
- No substitute for doing a full run through of the experiment



Pre-lab

Preparation: brought to you by the muppets



<http://www.youtube.com/watch?v=FnblmZdTbYs>

Pre-Lab Reports

- A good chance to dispel recipe-following
- Ask them for a more conceptual report, rather than a list

Pre-lab: Measurement of the charge to mass ratio of the electron

Junfei Geng

Partner: Dan Goodner

Date: 09/05/99

I. Physical principle: The measurement of this lab is to show the effect of electric and magnetic fields on charged particles. An electron moving in a magnetic field and perpendicular to the field is acted on by the force.

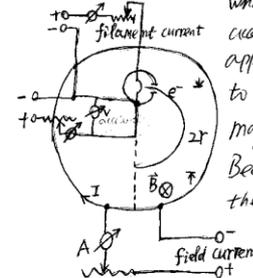
$$\vec{F} = Bev = q(\vec{v} \times \vec{B})$$

The force is a centripetal force: $F = ma = m\frac{v^2}{r} = Bev$, where r is the radius of the path. To get a velocity v , the anode accelerates the electron with a positive voltage V : $\frac{1}{2}mv^2 = eV$. Combining these equations, one can get:

$$\frac{e}{m} = \frac{2V}{B^2 r^2}$$

Once we find V , r and B (B can be found by Helmholtz Coil equation: $B = \frac{\mu_0 N I R^2}{(d^2 + R^2)^{3/2}}$) from the experiment, the charge to mass ratio can be determined.

II. Apparatus:

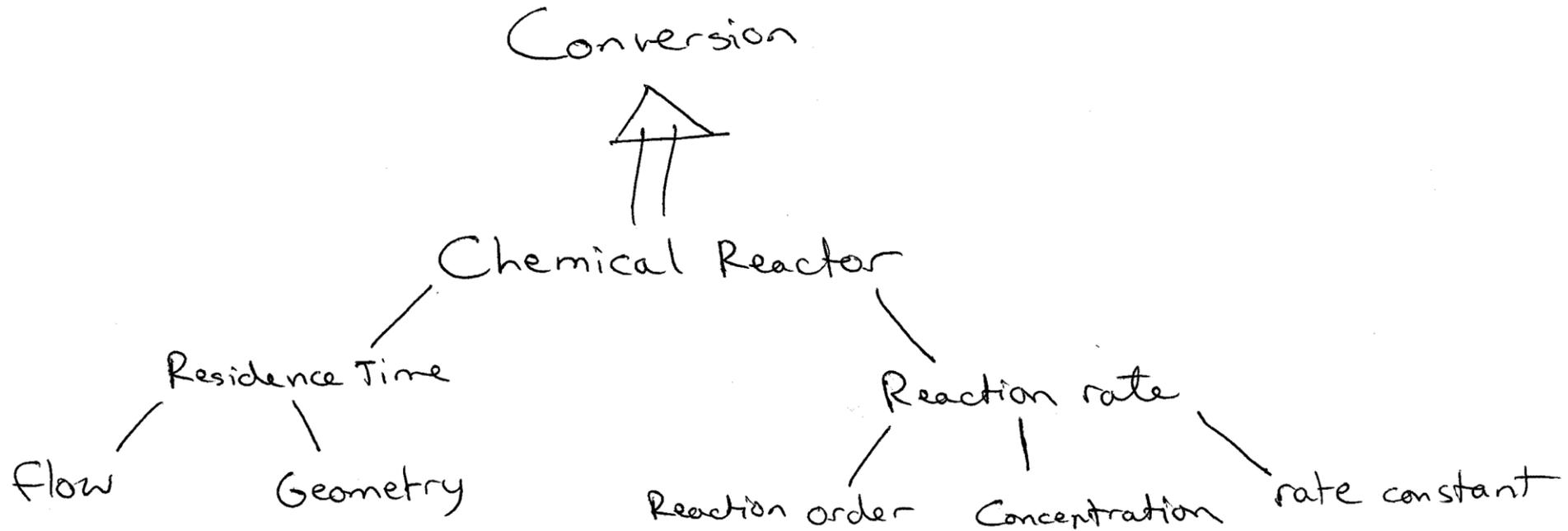


This apparatus depicts a large evacuated bulb where electrons, which are supplied by a heated filament, are accelerated to a known velocity by a potential difference applied between the filament and the anode and are caused to move along the arc of a circle by the uniform magnetic field supplied by the Helmholtz Coils. Because some mercury vapor is present in the bulb, the electron path as they collide with and ionize the mercury atoms can be seen.

Concept Maps

- A form of diagram for exploring, gathering, and sharing information
- Links explain the relationship between ideas and concepts
- Method of communicating thoughts, plans and ideas

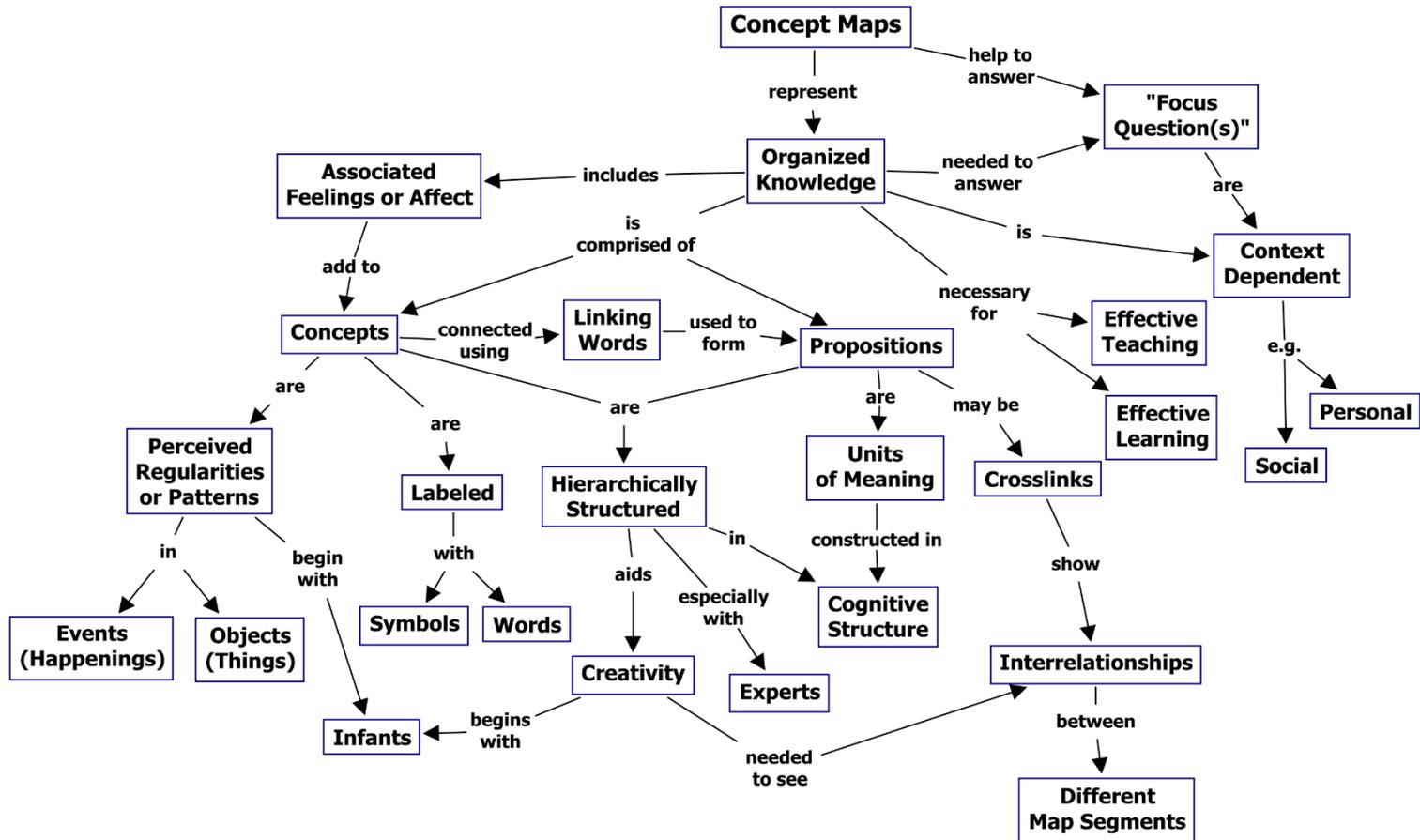
Concept Map: Hand writing



Concept Map: Sticky notes



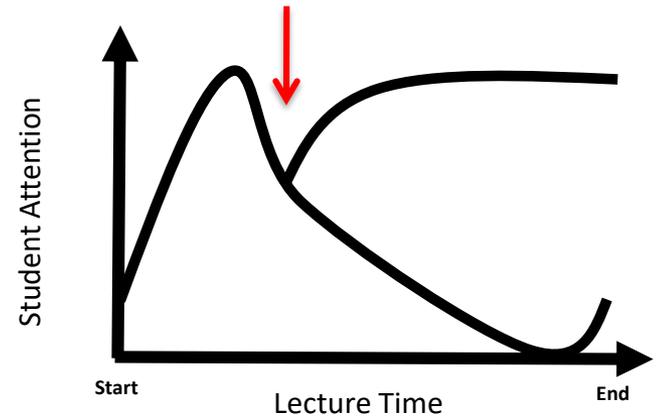
Concept Map: Software tools (e.g. Cmaps)



Demonstration

- Make sure everyone can see before you begin!
- Describe what you are doing as you do it
- Plan time for questions

Presentation

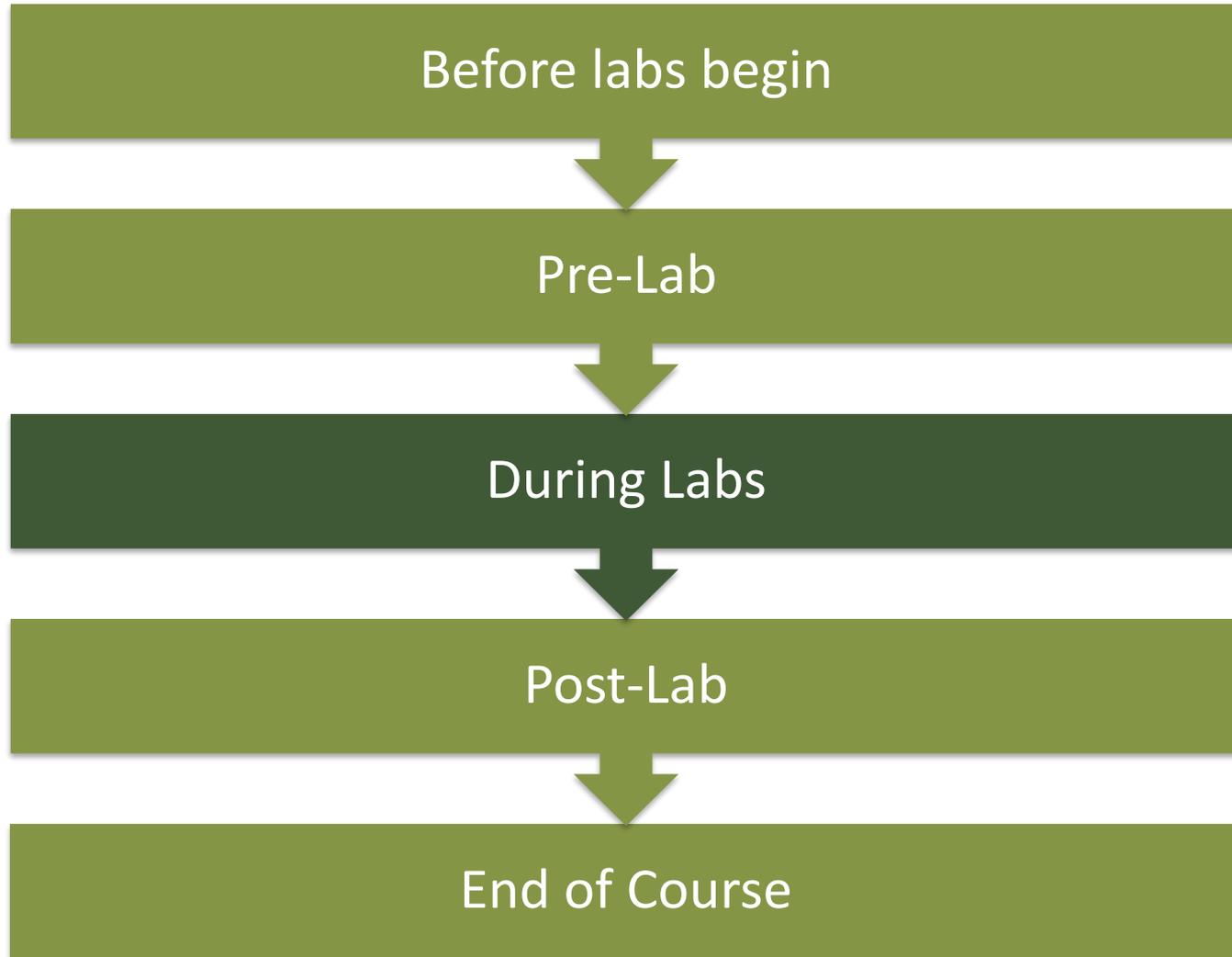


- Use learning objectives
 - Clearly define what they are expected to know
- A student's attention span is **18-22 minutes!** Keep it under this time, or break it up
 - **RESET:** A way to re-gain student's attention so they become attentive once more and can absorb more information
 - E.g. YouTube video, question period, activity

Presentation

- Often old presentations given to you
 - Advantages and disadvantages
- Use personal stories and speak to your interests
 - Students are interested to hear about this person teaching them! They'll perk up!
- You're the "expert"!

Semester Timeline



Turning them loose

- In the lab
 - Circulate, ask questions, answer questions
- Outside of the lab
 - Give the students your e-mail
 - Encourage office hours or appointments
- Get them to discuss
 - Get them in the habit that you are not the only point of contact

During the
lab

Ice-Breakers



ACTIVITY:

5 min: With others around you, brainstorm some activities you can use to get your students comfortable with each other before the lab sessions start.

5 min: Share your ice-breaker ideas with the room

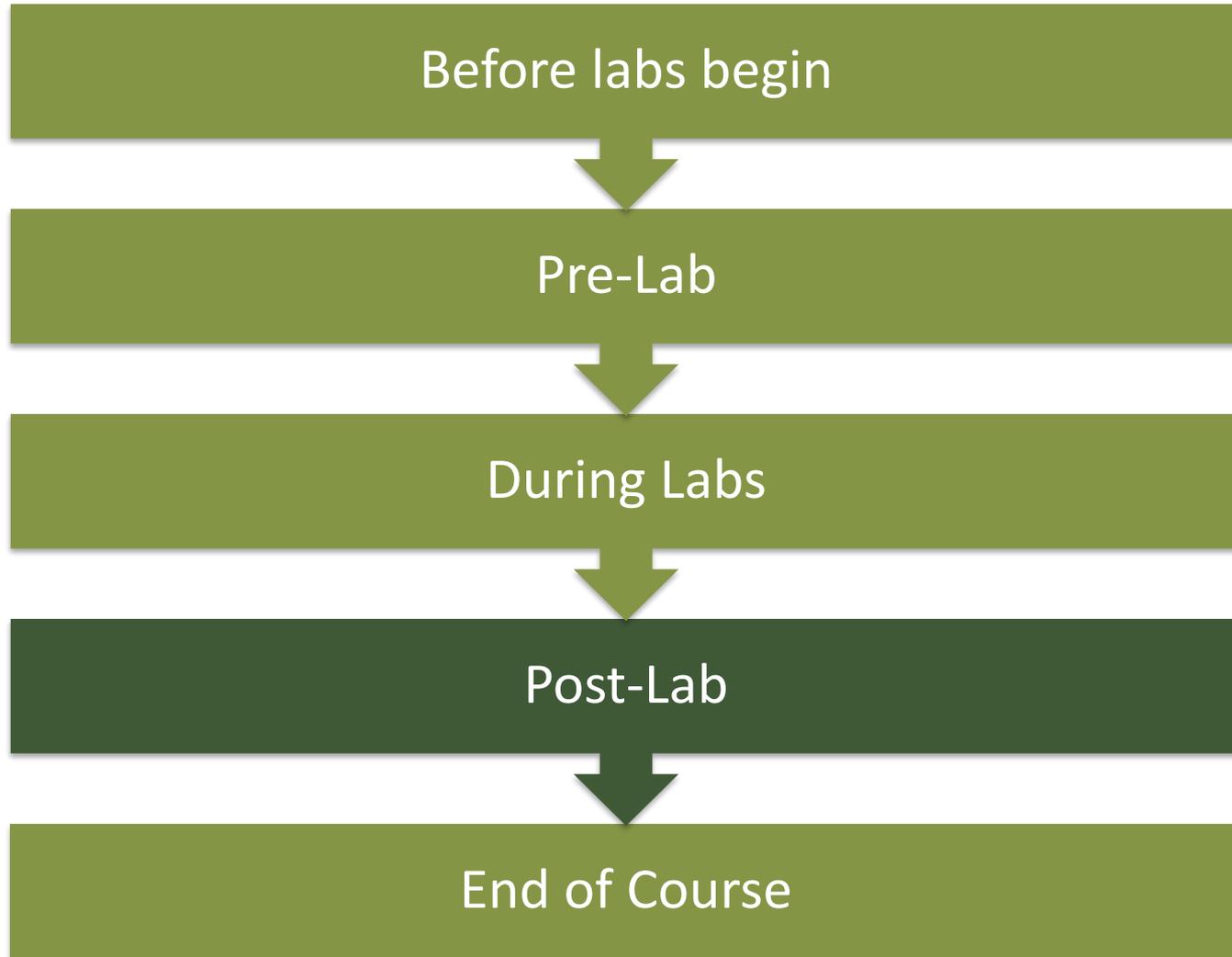
Timing

- Keep your students on time!
 - Inform them where they should be in the procedure by a given time
- Expect to be in the lab the full time
- Use downtime to engage with students or ice-breakers

Final Thoughts

- Encourage the spirit of science: exploration and experimentation
- Be enthusiastic
- You're not the only expert in the room: use student interaction
- Experience will come with time

Semester Timeline



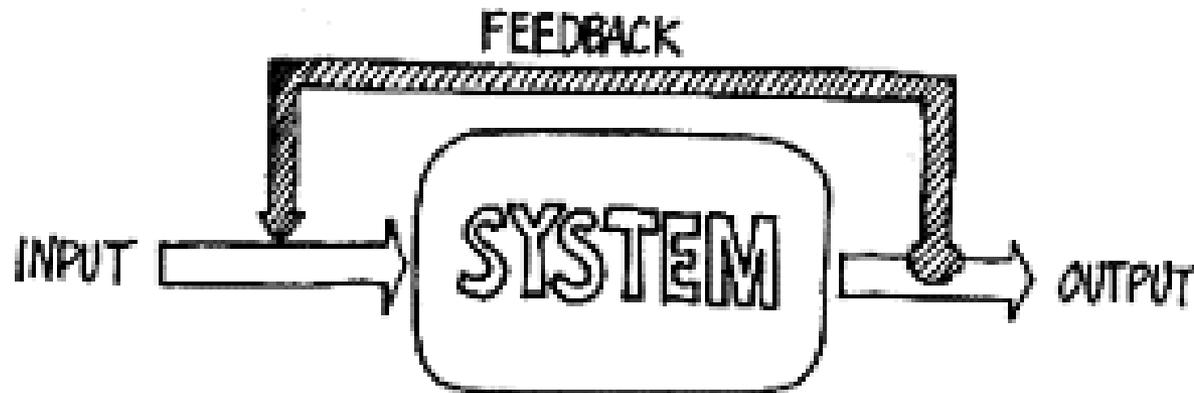
Discussion Period

- Some labs let students go on as they complete their experiments
 - You may instead have students wait for a discussion period at the end:
 - Walk through the experiment together
 - Discuss difficulties
 - Address questions



Lab Reports

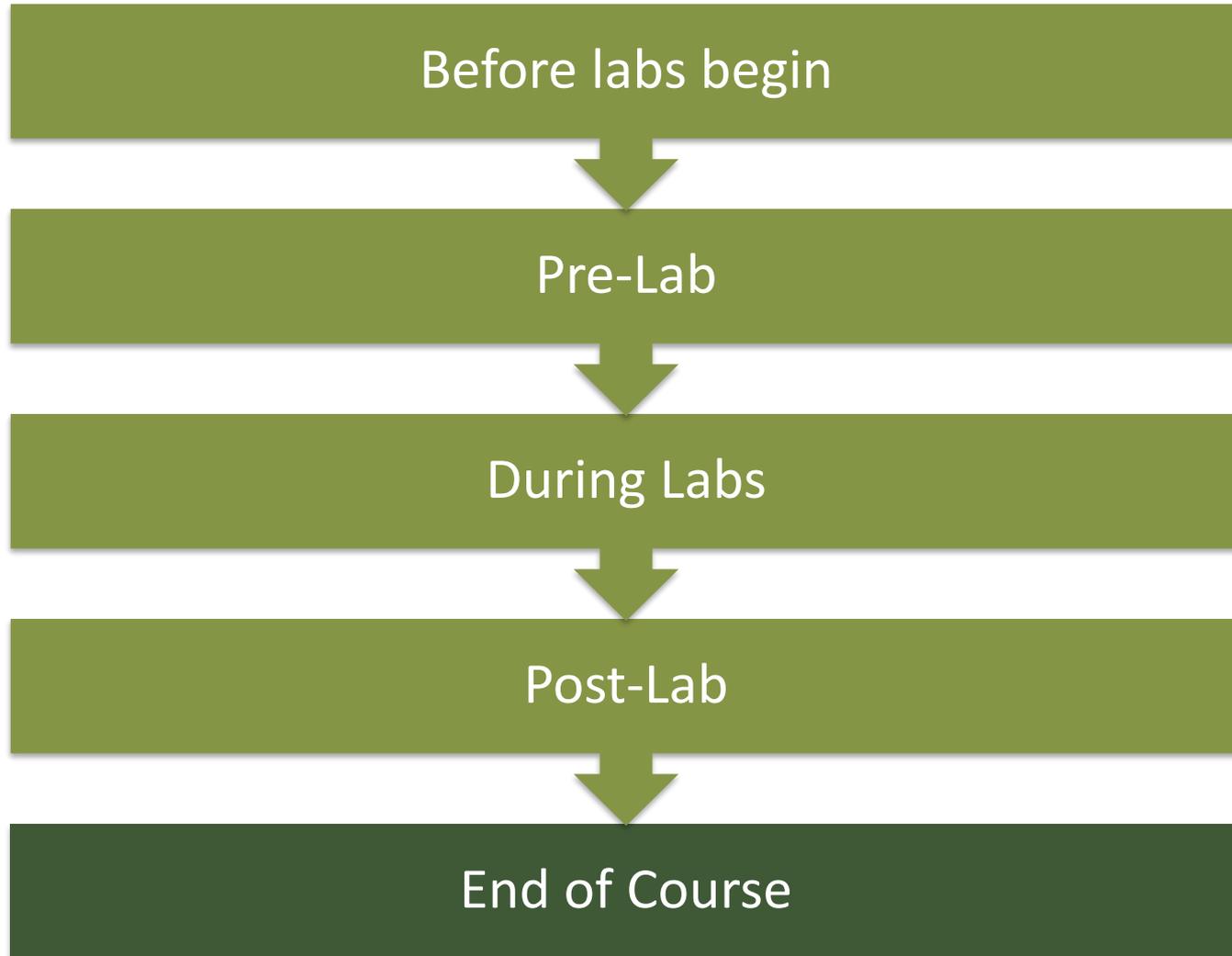
- Great opportunity for feedback
 - Focus on 2-4 most important skills
 - Be specific!
 - Many ways to give feedback
 - Make sure your criteria and standards are clear for students (rubrics, structure of past reports)



Student feedback

- Ask students about their opinion of the lab and your role as a TA
 - Make it anonymous
 - Do it in the lab on pieces of paper
 - Can also be done online (myCourses, Socrative, Turning Point)
 - Shows you want to improve your teaching and care about students

Semester Timeline



Wrapping up

- Remind students of Mercury course evaluations
- Have a final checkout meeting with instructors and TAs
 - Main problems this year
 - Ideas for next year

Resources: For You (TAs)

- Teaching and Learning Services (TLS)
 - <http://www.mcgill.ca/tls/>
 - Has a list of teaching resources
 - Teaching for learning blog
- T-PULSE
 - Workshops
 - Contact us anytime!
 - <http://www.mcgill.ca/tpulse/>
- Association of Graduate Students Employed at McGill (AGSEM)
 - <http://agsem-aedem.ca/>
 - <http://tas.agsem-aedem.ca/category/quality-of-education-blog/>
- Post-Graduate Students Society (PGSS)
 - <http://pgss.mcgill.ca/home>

Resources: For Your Students

Resource	Web Address www.mcgill.ca/...
Office for Students with Disabilities	osd/
Mental Health Services	mentalhealth/
International Student Services	internationalstudents/
Chaplaincy Services	chaplaincy/
Student Health Service	studenthealth/
Student Aid Office	studentaid/
Tutorial Service	tutoring/
Dean of Students	deanofstudents/
Counselling Service	counselling/
T-PULSE	science/tpulse/
Midnight Kitchen	themidnightkitchen.blogspot.com/

