Fostering Career Development through Research Learning Experiences

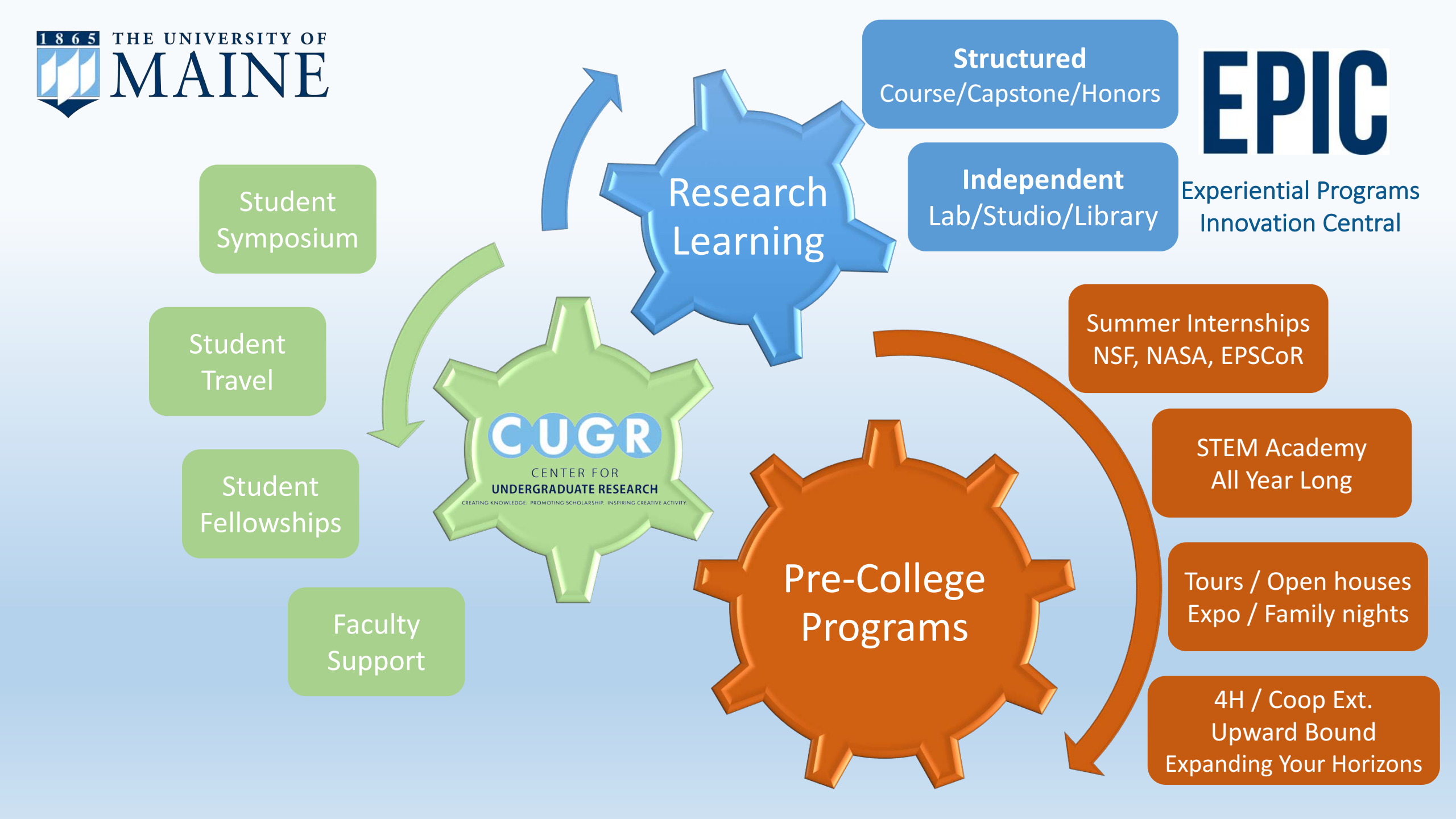
Organizers:

- Joan Ferrini-Mundy, PhD, President, University of Maine and University of Maine at Machias
- Ali Abedi, PhD, Associate VPR, Director of Center for Undergraduate Research

Presenters:

- Mauricio Pereira Da Cunha, Professor, Director of the Microwave Acoustic Lab
- Sally Molloy, PhD, Assistant Professor of Genomics
- Melissa Maginnis, PhD, Associate Professor, Associate Director of CUGR

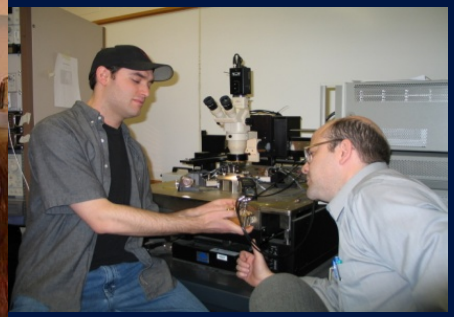
1865 THE UNIVERSITY OF MAINE


THE UNIVERSITY OF MAINE
1865
EPIC
Experiential Programs
Innovation Central
Structured
Course/Capstone/Honors
Independent
Lab/Studio/Library
Research
Learning
Student
Symposium
Student
Travel
Student
Fellowships
Faculty
Support
CUGR
CENTER FOR
UNDERGRADUATE RESEARCH
CREATING KNOWLEDGE. PROMOTING SCHOLARSHIP. INSPIRING CREATIVE ACTIVITY.
Pre-College
Programs
Summer Internships
NSF, NASA, EPSCoR
STEM Academy
All Year Long
Tours / Open houses
Expo / Family nights
4H / Coop Ext.
Upward Bound
Expanding Your Horizons

OUTLINE

I. Current Techniques used to create Undergraduate Awareness and Engagement in Research & Scholarship (R&S)

II. Required and Elective Undergraduate Course Activities: Awakening & Preparing for R&S



Examples:

- Fields and Waves (required)
- Microwave Engineering (elective)
- Sensor Technology and Instrumentation (elective)

III. New Initiatives under Discussion & Implementation @ UMaine

- Research & Scholarship exposure at 100 level course campus wide
- Single area / Multidisciplinary Undergraduate R&S
- Acknowledgement of student's activities: mention in end of course graduation

1865 THE UNIVERSITY OF MAINE

ELECTRICAL & COMPUTER ENGINEERING Orono, Maine

FIRST Frontier Institute for Research in Sensor Technologies

I. Techniques used to create Undergraduate Awareness and Engagement in Research & Scholarship (R&S)

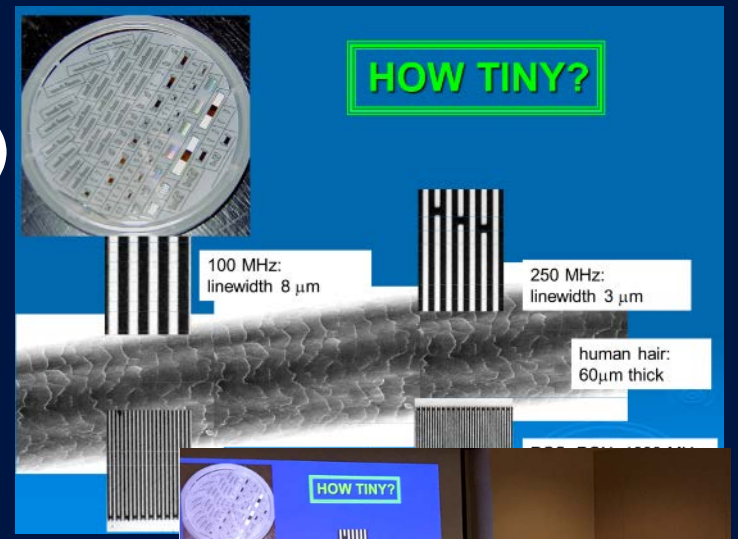
I. Basic courses → Initial exposure to R&S

- 101 courses: **Motivational** R&S talks & activities
  - ✓ Hands on circuits, robotics, Legos, challenges
- **Support**: Profs. & Lectures → fostering interest & interactions to discovery

Really Cool, Top-Notch, & World Class Research at UMaine

II. Undergraduate R&S Engagement

- NSF/REU: Summer program on Sensors (others on campus)
- R&S continuation after summer → During academic year
  - ✓ Work close with Grad. Students & Research Associates
- Presentations in
  - ✓ Project Group Meetings
  - ✓ UMaine Student Symp. & Professional conferences
- Path for Critical thinking & Graduate Studies



1865 THE UNIVERSITY OF MAINE

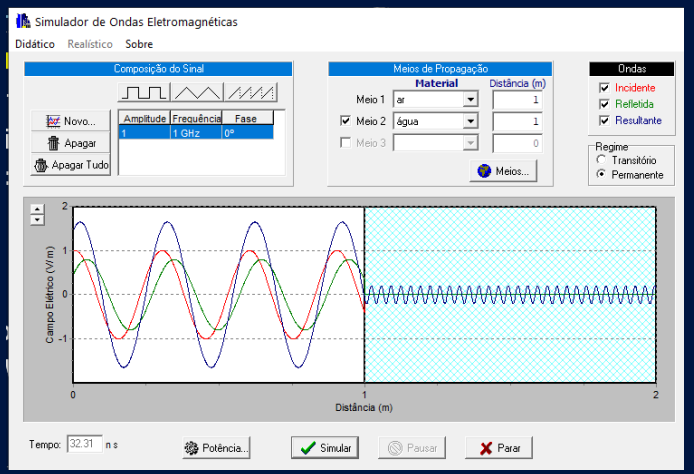
FIRST Frontier Institute for Research in Sensor Technologies

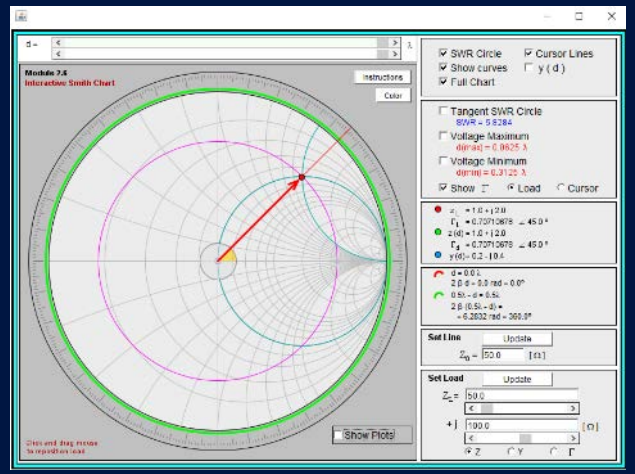
ELECTRICAL & COMPUTER ENGINEERING Orono, Maine

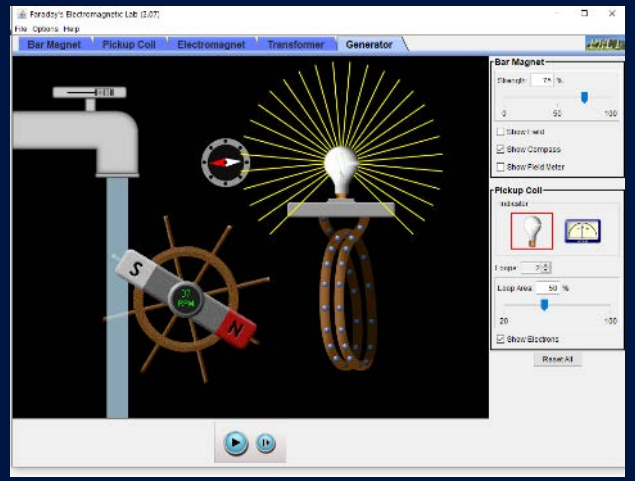
II. Required and Elective Undergraduate Course Activities: Awakening & Preparing for R&S

Basic course → Example: 351 Fields & Waves (2nd Year EE / required)

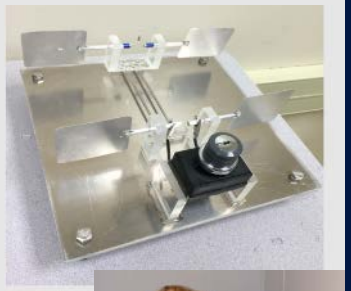
- Course traditional format → Lecture → Hybrid alternatives sought
- Interactive software → student engage in creative & exploratory activities
  - Prep: myself / colleagues / www / textbook

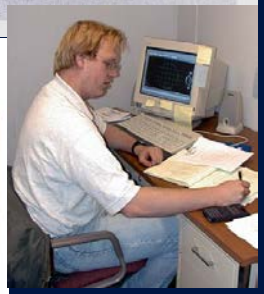






Hertz's Experiment





Crazy Pendulum

Lenz's Law

- Hands on Demo. (8 / prep. By UG R students)
- Prof. & my grad. & undergrad. Research students → TAs → 3h office h advising

1865 THE UNIVERSITY OF MAINE

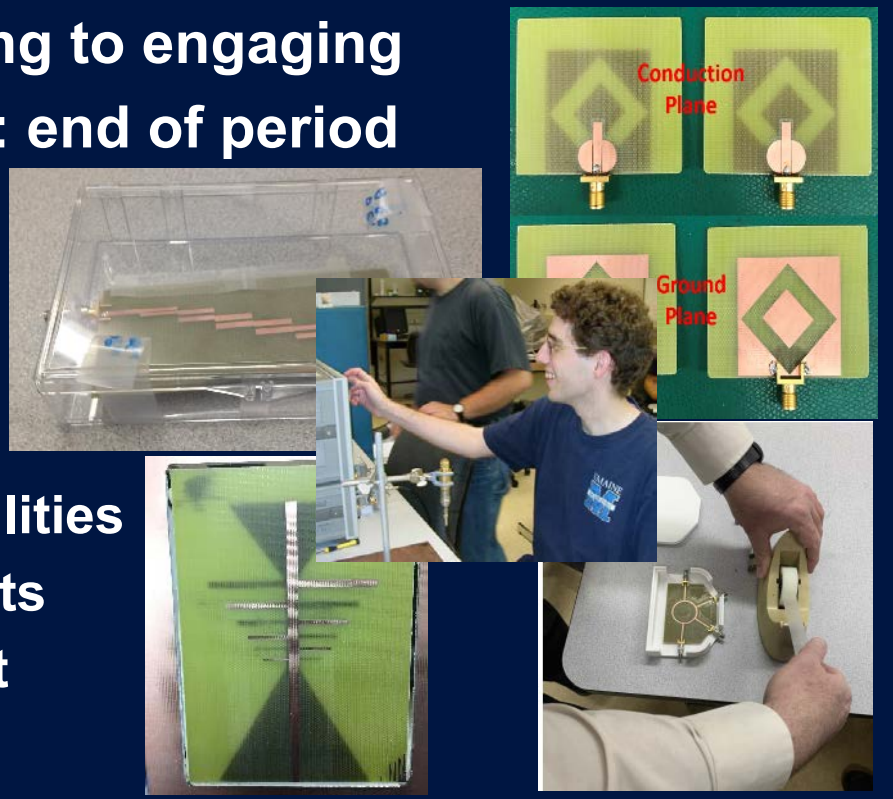
ELECTRICAL & COMPUTER ENGINEERING
Orono, Maine

FIRST
Frontier Institute for Research in Sensor Technologies

II. Required and Elective Undergraduate Course Activities: Awakening & Preparing for R&S

Elective Course → Example: 453 Microwave Engineering (Junior / Senior / Grad)

- Lecture / Lab / Project → Entire spectrum from orienting to engaging
- Project Course Activity ➔ START: 1st Month → FINISH: end of period
  1. Research Topic → Group activity (Guided)
  2. Select Topic (Guided)
  3. Defend topic to class → Technical and feasibility
  4. Industry Grade Radio Frequency Software Simulations
  5. Design & fab. at UMaine / Research grade & equip. facilities
  6. Testing & comparison with previously simulated results
  7. Final presentation to class & professional level report
- Research oriented activities:
  - Literature search & awareness / critical thinking / Individual & group initiative & work
  - Technical & professional writing



1865 THE UNIVERSITY OF MAINE

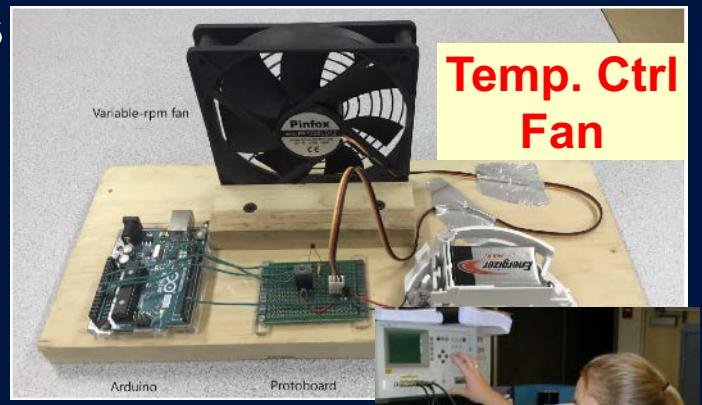
ELECTRICAL & COMPUTER ENGINEERING Orono, Maine

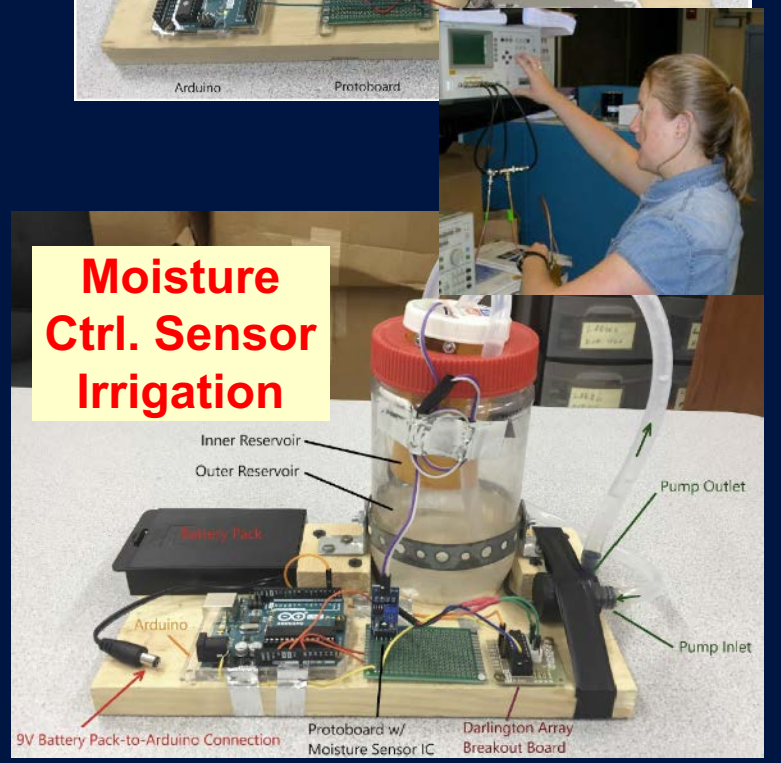
FIRST Frontier Institute for Research in Sensor Technologies

II. Required and Elective Undergraduate Course Activities: Awakening & Preparing for R&S

Elective Course → Ex.: 466 Sensor Tech. and Instrumentation (Jr. / Senior / Grad)

- Lab / Lec. / Project → Hands on multiple (eight) sensor topics
- Project Course Activity ➔ Distributed along the semester
  - i. Topic search → Individual activity (Guided)
  - ii. Proposal prep. → basics / soundness / materials / BUDGET
  - iii. Defense to peers (class)
  - iv. Discussion / Vote / Selection of best proposals
  - v. Implementation of the best proposals by the groups
  - vi. Final presentation to class & professional level report
- Research oriented activities:
  - Literature search & awareness / critical thinking / Individual & group initiative & work
  - Technical & professional writing





1865 THE UNIVERSITY OF MAINE

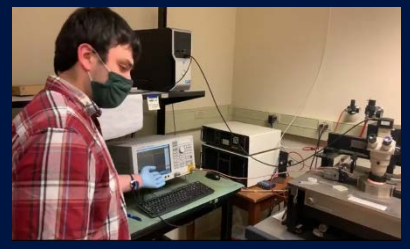
ELECTRICAL & COMPUTER ENGINEERING Orono, Maine

FIRST Frontier Institute for Research in Sensor Technologies

II. Required and Elective Undergraduate Course Activities: Awakening & Preparing for R&S

IMPACT FOR UNDERGRADUATE STUDENTS

- ✓ "This course helped me land my job in RF: project design, fabrication, testing provided hands on experience that impressed (hiring) engineers."
- ✓ "453 was most impactful and I enjoyed the most … made me decide that I wanted to apply to the PhD program here at UMaine."
- ✓ "It was very interesting to go through the entire creation, design & fabrication process of a microstrip circuit."
- ✓ "We actually did real "industry" work in 453."
- ✓ "Latest real-life sensor in lab & understanding sensor concepts. Huge impact in my interest in this area."
- ✓ "I use sensors in my work, and this lab helped me understand them."
- ✓ "Perfect balance of getting you to figure stuff out vs. telling you how to solve a problem."



III. New Initiatives under Discussion & Implementation @ UMaine

U. of Maine → Wider Student Population Targeted Initiative

- Visits & presentation to high school students
- Incentive from President Joan Ferrini-Mundy
- Univ. of Maine Senate Committees currently involved:
  - ✓ Academic Affairs / Research & Scholarship / Finance and Institutional Planning
- University wide UNDERGRADUATE exposure to Research & Scholarship
  1. All departments / academic units expected to engage
  2. Intro to Research & Scholarship → One or two classes
     - ✓ Embedded in 100 level courses
     - ✓ Unit major related research OR Multidisciplinary

1865 THE UNIVERSITY OF MAINE

ELECTRICAL & COMPUTER ENGINEERING Orono, Maine

FIRST Frontier Institute for Research in Sensor Technologies

III. New Initiatives under Discussion & Implementation @ UMaine

Univ. of Maine → Wider Student Population Targeted Initiative

- (cont.) **University wide UNDERGRADUATE exposure to Research & Scholarship**
  1. All departments / academic units expected to engage
  2. Intro to Research & Scholarship → One or two classes
     - ✓ Embedded in 100 level courses
     - ✓ Unit major related research OR Multidisciplinary research
  3. **Invitation for paper / proposal from 1st Year students for UG research**
     - ✓ Competition → best 100-level course proposals voted / selected by the students
     - ✓ If acad. unit related → Course instructor direct to Dept. funded Research projects
     - ✓ If multidisciplinary → Course instructor direct to respective Deans / researchers
     - ✓ If UG best voted proposal does not find home in Units → consideration for Presidential seed support
       - Advised by faculty related to the area or
       - Research independently run by the students

1865 THE UNIVERSITY OF MAINE

ELECTRICAL & COMPUTER ENGINEERING Orono, Maine

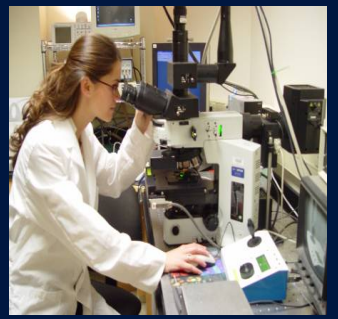
FIRST Frontier Institute for Research in Sensor Technologies

III. New Initiatives under Discussion & Implementation @ UMaine

Univ. of Maine → Wider Student Population Targeted Initiative

- (cont.) **University wide UNDERGRADUATE exposure to Research & Scholarship**

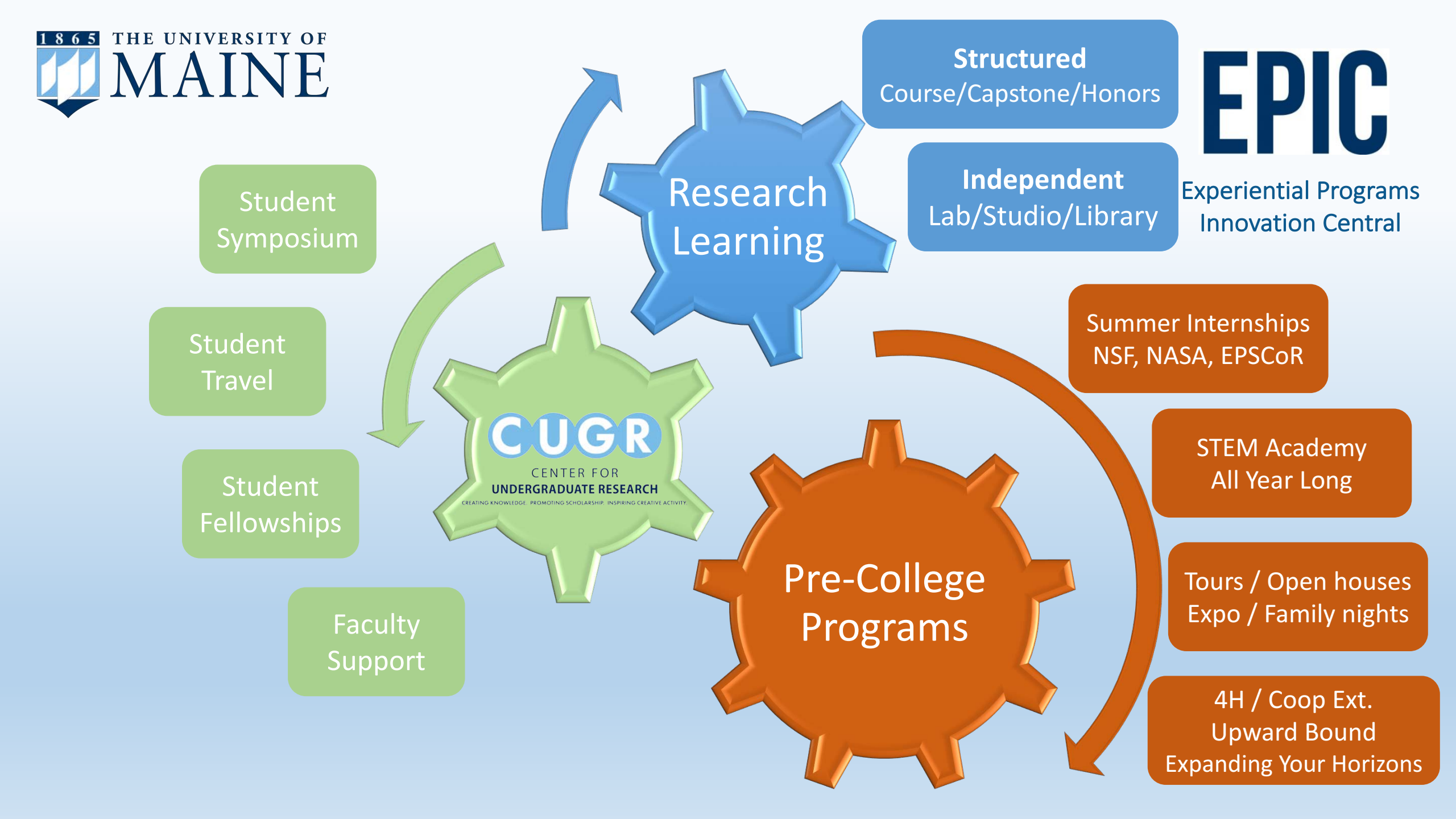
1. All departments / academic units expected to engage
2. Intro to Research & Scholarship → One or two classes
   - ✓ Embedded in 100 level courses
   - ✓ Unit major related research OR Multidisciplinary research
3. Invitation for paper / proposal from 1st Year students for UG research
   - ✓ Competition → best 100-level course proposals voted / selected by the students
4. **Students who engage in UG research during their time @ UMaine:**
   - ✓ **Should have that activity acknowledge in their end-of-course graduation**



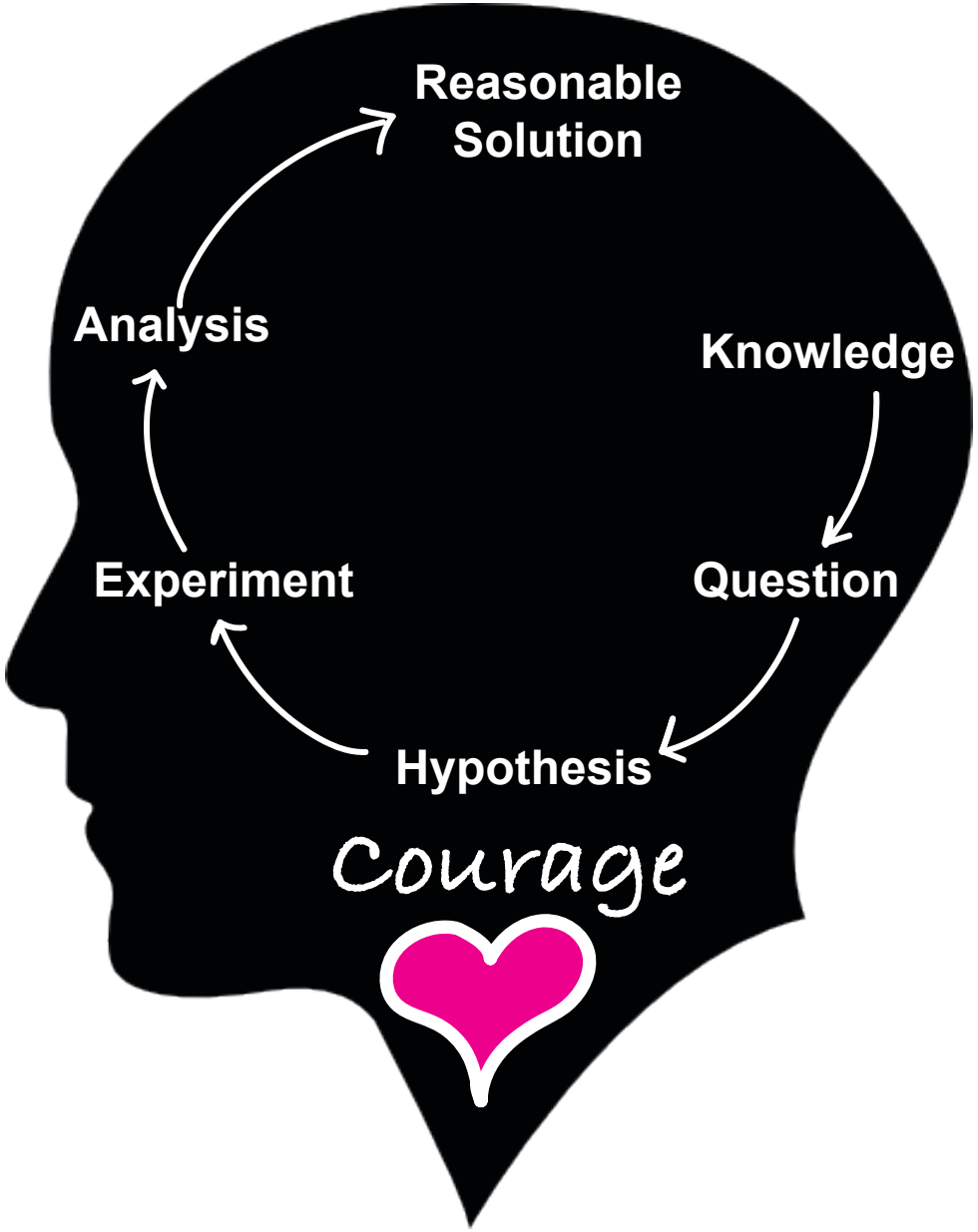
1865 THE UNIVERSITY OF MAINE

ELECTRICAL & COMPUTER ENGINEERING Orono, Maine

FIRST Frontier Institute for Research in Sensor Technologies

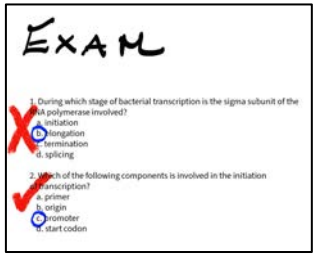

THE UNIVERSITY OF MAINE
1865
EPIC
Experiential Programs
Innovation Central
Structured
Course/Capstone/Honors
Independent
Lab/Studio/Library
Research
Learning
Student
Symposium
Student
Travel
Student
Fellowships
Faculty
Support
CUGR
CENTER FOR
UNDERGRADUATE RESEARCH
CREATING KNOWLEDGE. PROMOTING SCHOLARSHIP. INSPIRING CREATIVE ACTIVITY.
Pre-College
Programs
Summer Internships
NSF, NASA, EPSCoR
STEM Academy
All Year Long
Tours / Open houses
Expo / Family nights
4H / Coop Ext.
Upward Bound
Expanding Your Horizons

Cultivating Effective Scientific Thinkers



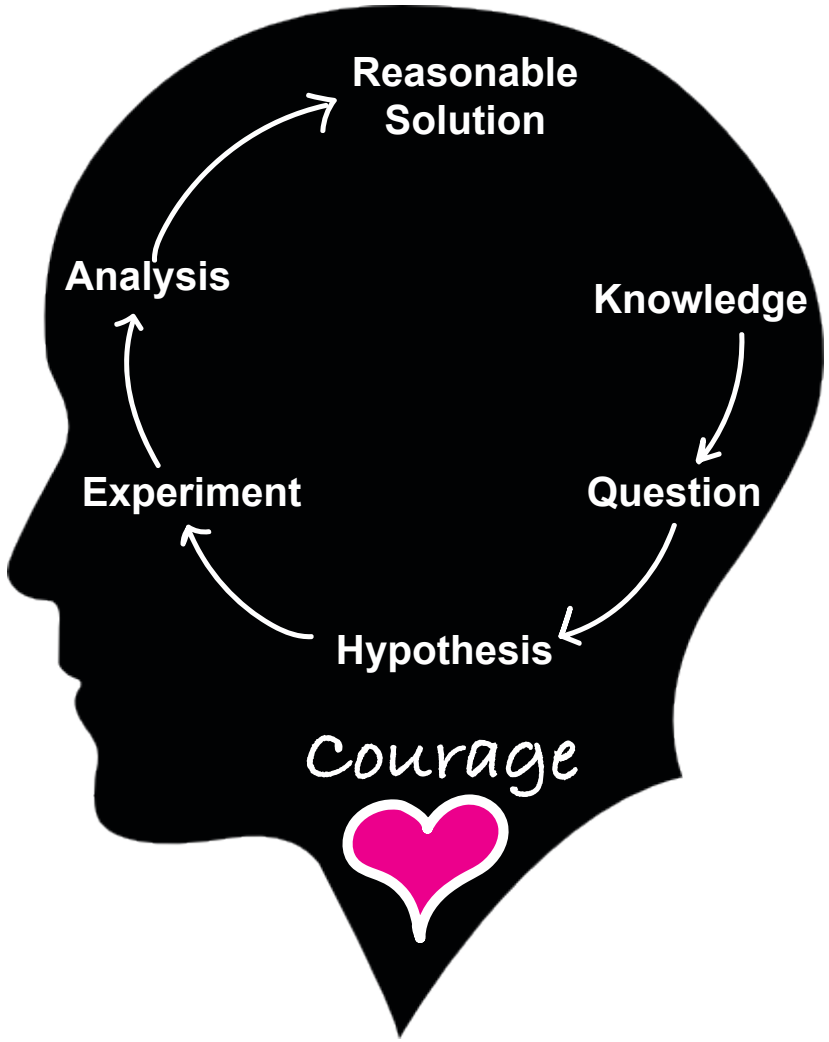
First-year Undergrad

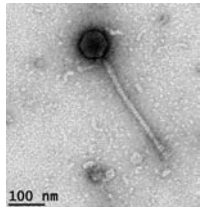
Knowledge →

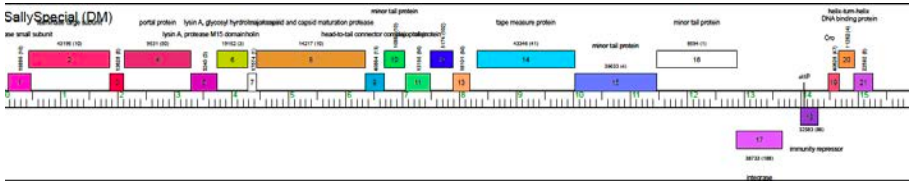


?

Effective Scientific Thinkers

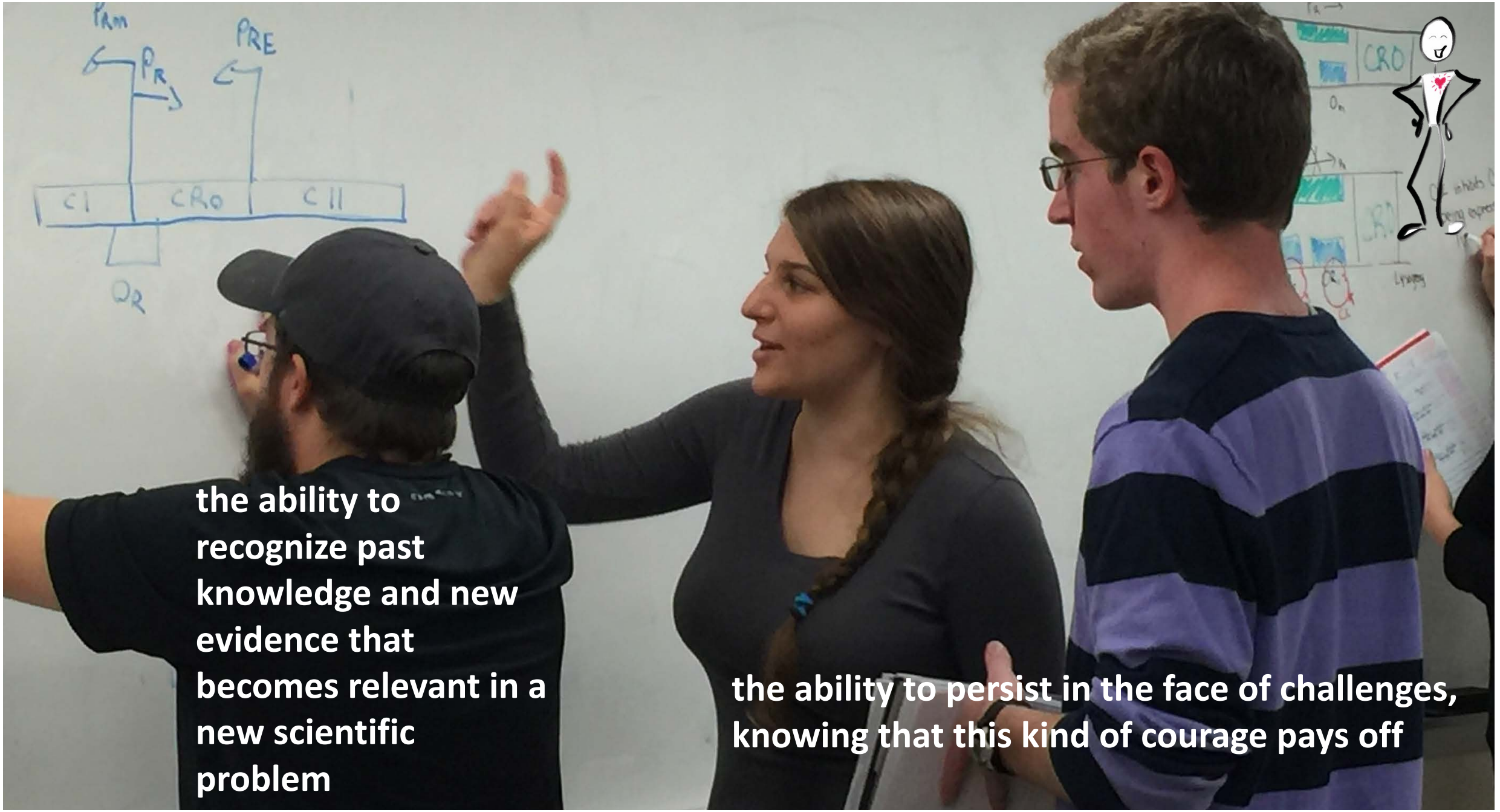






SEA PHAGES


the capacity for interdependent thinking


the ability to recognize past knowledge and new evidence that becomes relevant in a new scientific problem
the ability to persist in the face of challenges, knowing that this kind of courage pays off

Wisdom is the daughter of experience.

Da Vinci, L., *The notebooks of Leonardo da Vinci*

Reflect

Reflect: Students reflect on their understanding of new concept and their experience with learning habit/skill (e.g. solving impossible problems or effective collaboration).

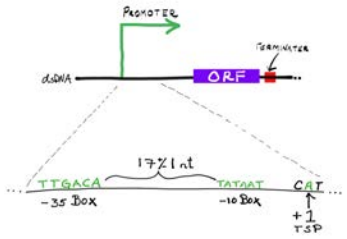
Strategize

Collectively develop a strategy for the challenging learning situation based on students' own experiences using that skill.

Model it!

Experience

Student model



Research Problem

```
>ProphiNQTL-1att
GGGGCGGTAGCTCAGTTGGTTAGAG
CCGTGGACTCATAATCCGTTTGGAT
GGTAGAATAAGCAGCATGAATGGTC
ACATTTGCGCAGGTAGAGCGACTTT
CATGTATTGCACTGTCTAGTCGCAT
GTAGCCCAATAGGCTACAGTGTTGG
CTACAGTAGAGCGGATTGGAGTTTG
CTGAATGGGGCAAAGGCGCACCCGC
GGTGACGGGGGACTCTACAAACGCA
GCGATGGCATGTGGGTCGGAGCCGT
CGATATCCCCACCGAAGATGGAAAG
CGCCGACGCCGAACTGTCTCCTCGA
AAGACAAGGCAACCGCCCTGGCGAA
GCTGCGCACCCTGCGATCTGAGATC
ACATCGGGGAAGGCGCCCACAACCT
CCAACACCACACTCGAACAGTGGCT
CACCCACTGGCTTGAGACCATCCAG
AAGCCGCGCGTACGTCCAACCACAT
TCAAGTACTACGAGACCACCGTCCG
TCTCTATATCCTGC
```

Reflect

Weekly Written Reflections: heightened awareness of conceptual understanding, gaps in knowledge, and the value of specific learning approaches and mindsets.

Reflect: Students reflect on their understanding of new concept and their experience with learning habit/skill (e.g. solving impossible problems or effective collaboration).

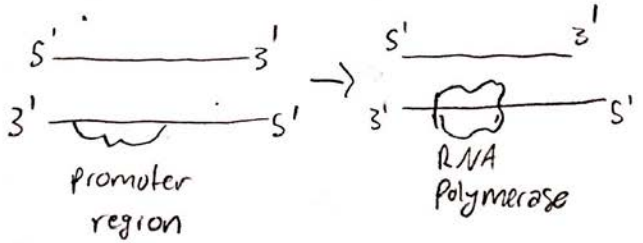
Let's get warmed up ☺

1. What strategy do you use when faced with a really difficult task or a question to which you do not immediately know the answer?

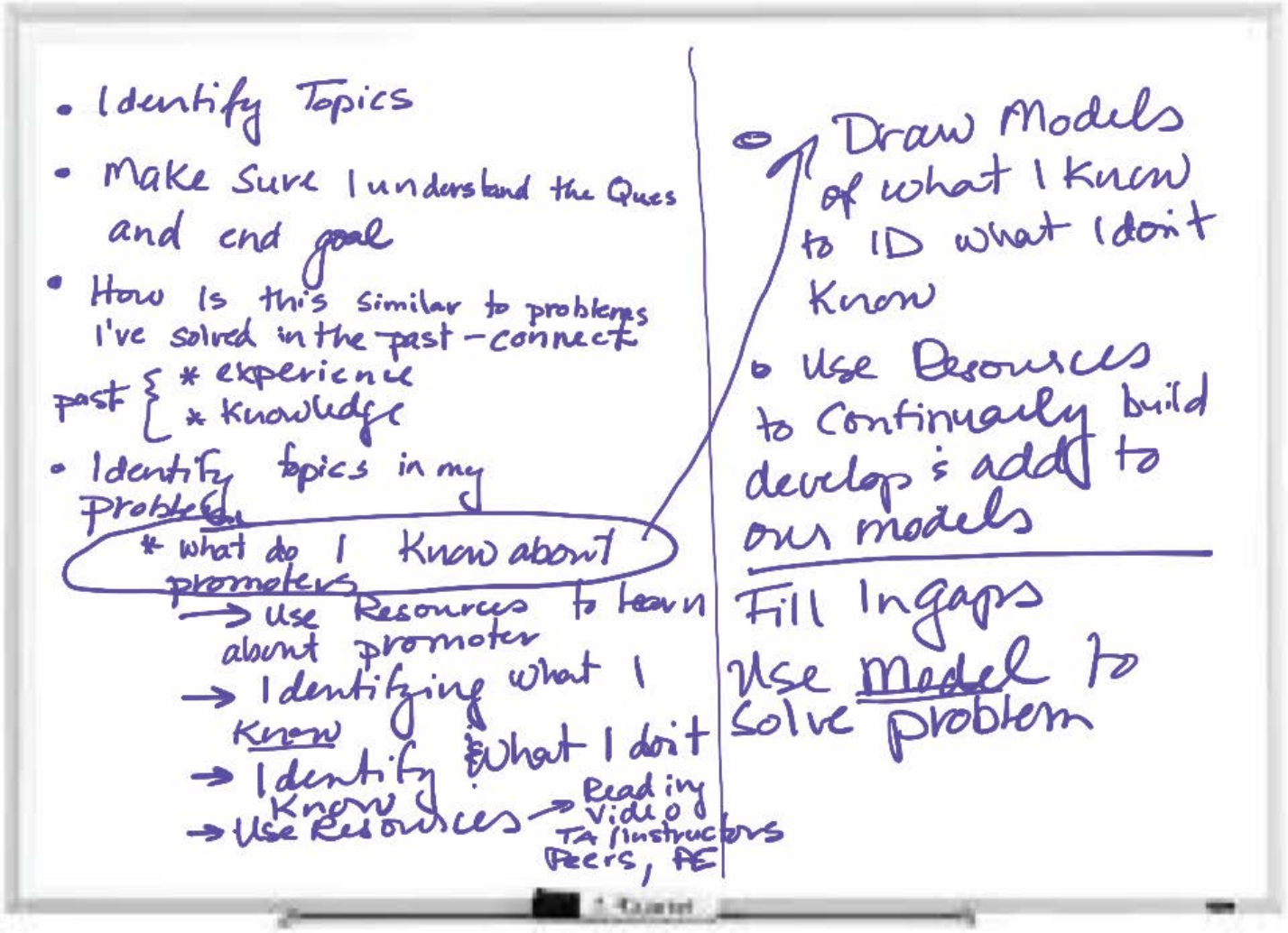
The best thing to do is break it down into pieces you know. Circle or highlight words that dictate what the question is looking for specifically. Also, you can look at the basic concepts behind the question to help you understand the bigger, more difficult question.

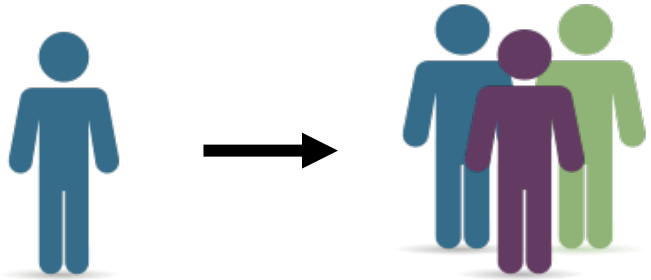
2. Using an illustration with text labels, describe your understanding of a bacterial promoter.

A bacterial promoter is a region on bacterial DNA that allows for RNA Polymerase to attach, leading to transcription. Promoters are important since they allow transcription to proceed.

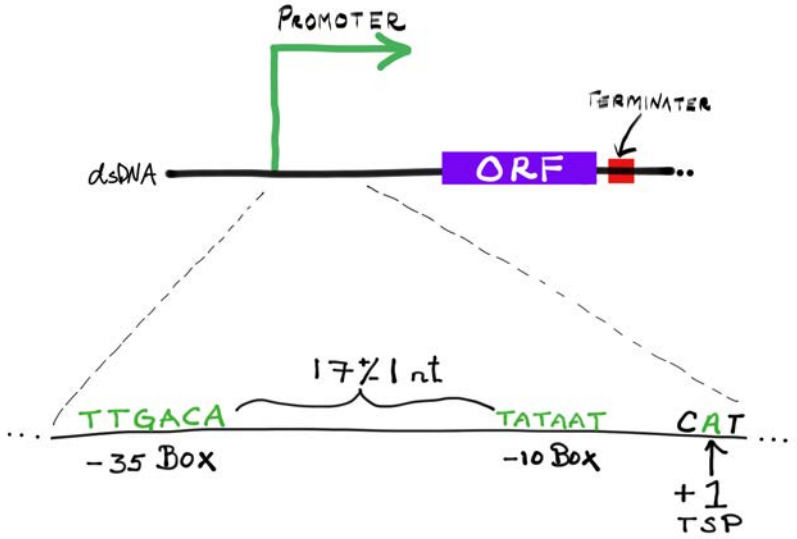


Strategize: Students collectively develop a strategy for the challenging learning situation based on students' own experiences using that skill.





Experience: Students construct knowledge and apply to research problems



DATA

>ProphiMcProf
TCTCGAAATTACCGGTAATGCAACTAGTAG
CTCGTGGTTGCTGAACCTTACAACATCACT
GCTCAGTGCGCAGGGCTTCGTTAGTCCGCC
CGCGTGGCGGACTAGTAGATTCGCTAGACA
CGCCATATCAGTGG**TTGACA**GAGTGATAGC
TAGTAGTT**GATGAT**CTACGC**A**TCCCGTTCA
CCTACTAGTCACCGCATCGTTATGGGGTGA
CGCTGAAGGGTTGTGAATAC**GTGGCGCACG**
ATGTCAGATCAGTCGAGGTCAAGAACCTAC
CGCTGCTGCGCAGCCTGGTCGGTCCTGAGC
CCGAGAAGCTGATGACGGCTCGTAA....

Reflect: students develop heightened awareness of conceptual understanding, gaps in knowledge, and the value of specific learning approaches and mindsets.

- *Describe in detail your most significant learning experience this week. In your writing, include specifically: (a) What you learned; and (b) a description of the experience that helped you learn it.*

This week, we finally got a taste for annotating some genomes! I was really excited to be able to BLAST our prophage genomes, even though the process was difficult to learn. Once we went over it in our small groups, it really helped me grasp the concept of BLAST and how to use it in our research. Having the basic understanding of gene structure that I did a few weeks ago left me a little confused on what exactly we would be doing, but after learning more about genes, gene structure, transcription and translation, the idea of using PECAAN, BLAST, and phaster became much easier to deeply understand.

Awesome Abi, things will start to make sense soon. I will probably confuse you some more this week. But there is a method to my madness so hang in there with me! We are going to dive in deep this week!

- *For the learning experience you described above, please answer the following two questions: (a) what emotions did you have; and (b) how did they impact your learning (before the event, during the event, after the event)?*

To be 100% honest, the first time BLAST and PECAAN were showed to us, my eyes kind of glazed over and I was thinking what I am getting myself into. After learning about the basic structure of genes, I had a better understanding of the components that these computer programs were talking about, which helped my deeply understand what exactly these programs are doing. As of right now, I am still not fully confident using the systems without some hiccups, but I am working on it, and I am excited that we have come this far! P.S. I am REAAALLLYYY excited for our upcoming research!!!

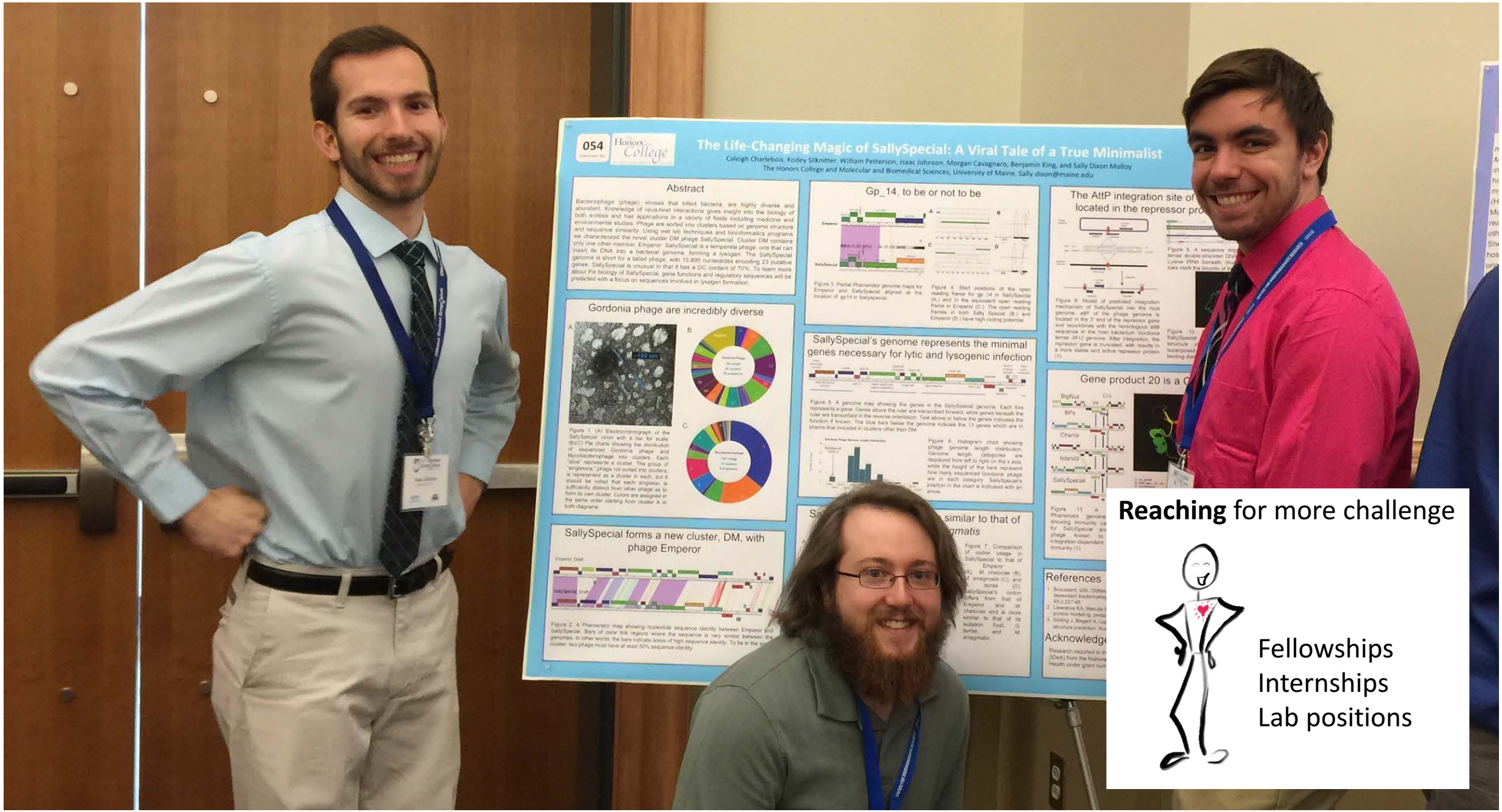
No worries Sbi, this will make sense as you do the analyses yourself. Don't forget our motto....you gotta get it wrong in order to get it right. That means diving in even when you are unsure is the only way to learn

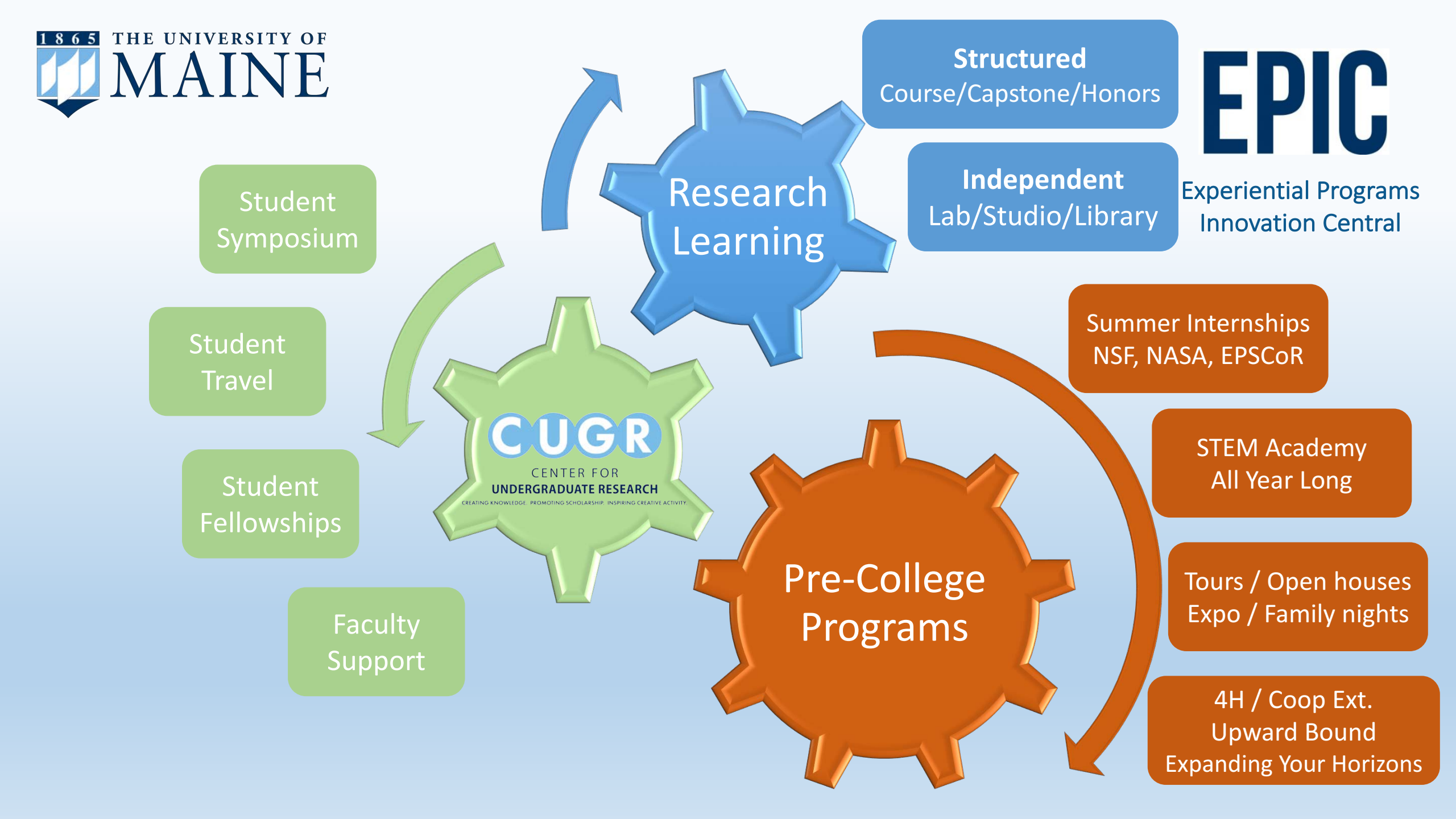
- *As you think about the learning experience, please answer the following questions: (a) what worked; (b) what didn't; and (c) what will you do in future learning to use what you learned from this experience?*

This week, the biggest problem I encountered was burnout. Lots of my other classes had some big assignments/exams, so my brain was partially fried once I got to class. It made it kind of hard for me to focus, especially earlier in the week when we were talking about the still somewhat unfamiliar topics of PECAAN and BLAST. Thankfully, I took enough breaks and spaced out my work for the rest of the week, and came prepared to class ready and excited to learn, so Thursday's class went much better for me. I am VERY thankful for the short little stretch and

At first glance of assignment 2, question 6 had me all sorts of confused. It was a lot to look at, lots of letters (nucleotide bases). After breaking the question down, I knew that the question was asking me to identify promoter sequences. I then drew back on the information of what a promoter sequence was, and how to identify them in a sequence. When I came across questions that I was unsure of, we all discussed them in our small group, and came up with a collaborative answer that made sense. **At the end of the question, I was surprised that it actually didn't take me that long to complete, and that I did it with ease. After I got past the initial shock of a 'scary and difficult really long question and was able to break it into manageable pieces to tie back to information that I had studied, the problem could be answered in just a couple of steps.** I really liked having my group mates to compare answers with, have discussions, and further my understanding on subjects I may had been a little unsure of.

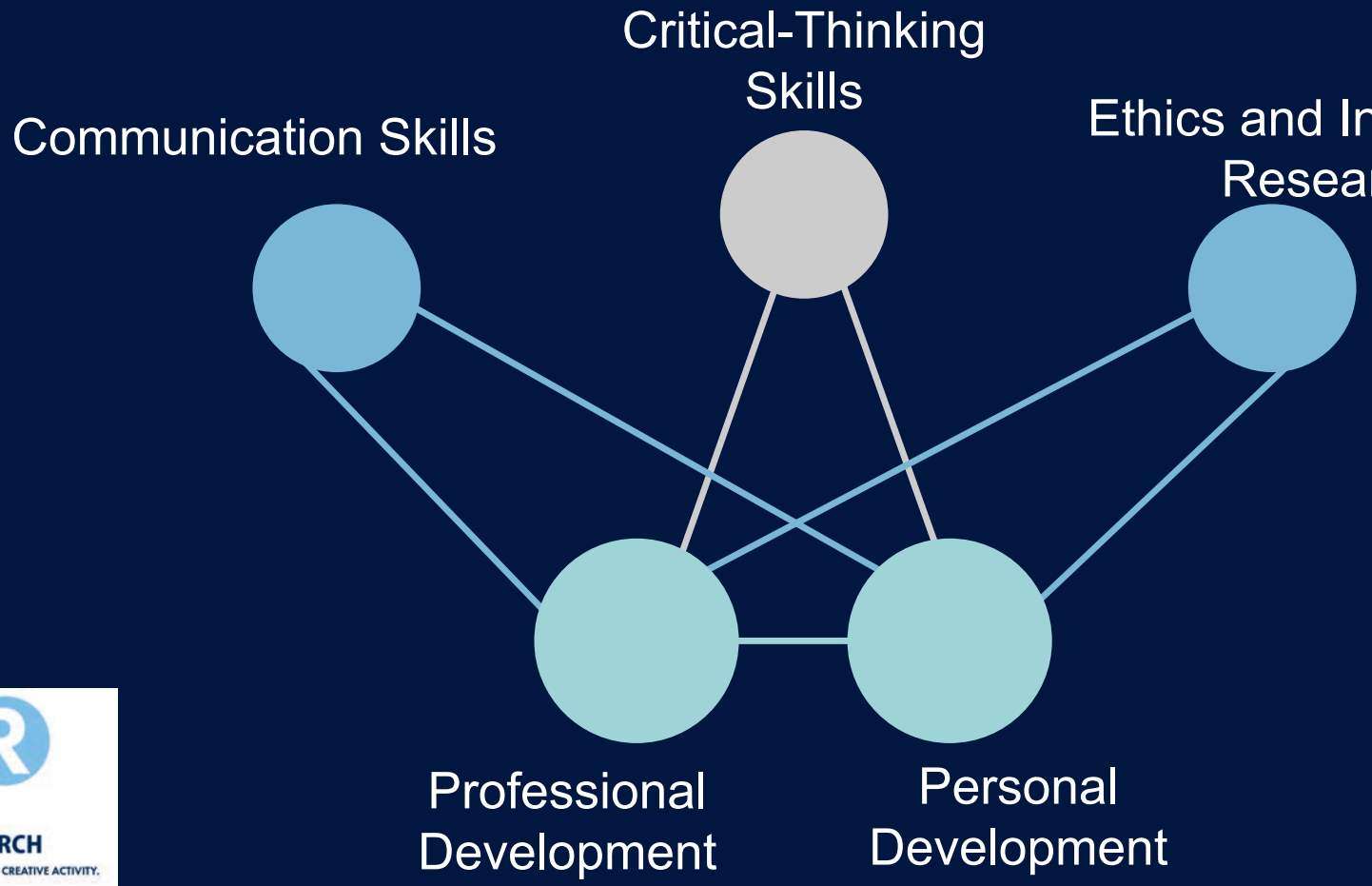
Completing research and solving difficult problems felt really good. I was always so nervous to jump in, but as soon as my toes were wet, I just wanted to swim! **The more research we did, and the more I learned about confusing concepts, the more I wanted to tackle difficult questions!** There definitely were times that I still was apprehensive about the work I was supposed to complete, but I felt like every time I didn't think I was capable of completing something, I always came out stronger in the end. **The more I finished these "impossible" tasks, the less scared I was for the next one.**


054
The Life-Changing Magic of SallySpecial: A Viral Tale of a True Minimalist
Caleigh Charlebois, Kodey Silknitter, William Petterson, Isaac Johnson, Morgan Cavagnaro, Benjamin King, and Sally Dixon Molloy
The Honors College and Molecular and Biomedical Sciences, University of Maine, Sally.dixon@maine.edu
Abstract
Gp_14, to be or not to be
The AttP integration site of
located in the repressor pro
Gordonia phage are incredibly diverse
SallySpecial's genome represents the minimal genes necessary for lytic and lysogenic infection
Gene product 20 is a C
SallySpecial forms a new cluster, DM, with phage Emperor
similar to that of
References
Acknowledge
Reaching for more challenge
Fellowships
Internships
Lab positions


THE UNIVERSITY OF MAINE
1865
EPIC
Experiential Programs
Innovation Central
Structured
Course/Capstone/Honors
Independent
Lab/Studio/Library
Research
Learning
Student
Symposium
Student
Travel
Student
Fellowships
Faculty
Support
CUGR
CENTER FOR
UNDERGRADUATE RESEARCH
CREATING KNOWLEDGE. PROMOTING SCHOLARSHIP. INSPIRING CREATIVE ACTIVITY.
Pre-College
Programs
Summer Internships
NSF, NASA, EPSCoR
STEM Academy
All Year Long
Tours / Open houses
Expo / Family nights
4H / Coop Ext.
Upward Bound
Expanding Your Horizons

Center for Undergraduate Research (CUGR)

Mission: *increase, improve, and enhance undergraduate students' participation and experiences in research, scholarship, and creative activity*



- Fellowships and Scholarships
- Travel Grants
- Student Symposium
- Faculty Fellows

CUGR
CENTER FOR
UNDERGRADUATE RESEARCH
CREATING KNOWLEDGE. PROMOTING SCHOLARSHIP. INSPIRING CREATIVE ACTIVITY.

Building Capacity for Undergraduate Research Experiences

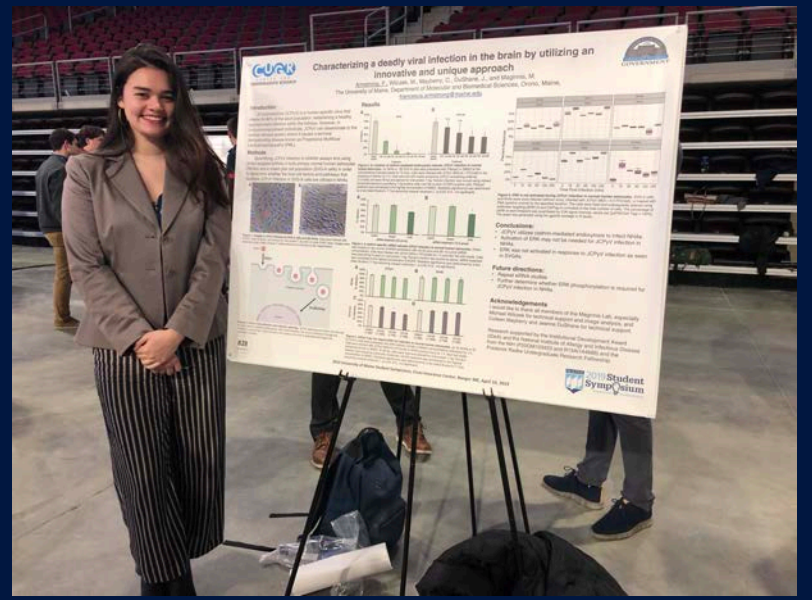
Faculty-mentored independent research project → Develop a research proposal → Authentic RLEs → Showcase Accomplishments Reflect Celebrate

Specific Aims

1. Establish whether activation of the ERK signaling pathway is required for JCPyV infection in primary astrocytes.
2. Determine whether DUSP6, a negative regulator of the ERK signaling pathway, influences JCPyV infection in primary astrocytes.

Experimental Plan

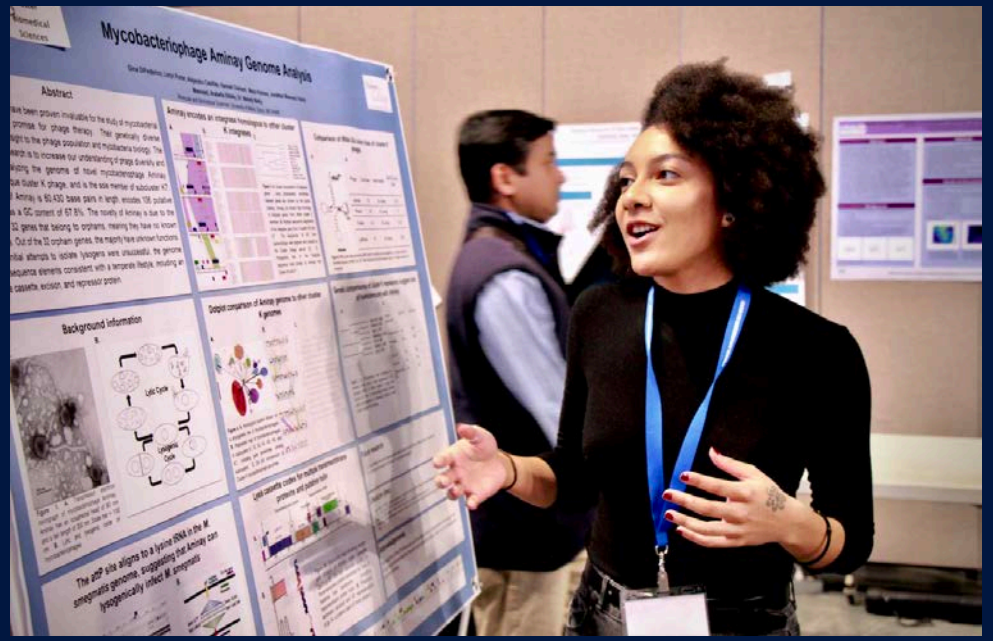
Aim 1: Establish whether activation of the ERK signaling pathway is required for JCPyV infection in primary astrocytes. JCPyV infection of SVG-A cells activates the MAPK/ERK pathway and requires ERK activation for infection (REF – DuShane 2018, 2019). However, p~~P~~reliminary studies to determine whether ERK is required for infection of primary astrocytes, suggest that utilization of ERK may not be required for JCPyV infection of primary astrocytes (NHAs) ~~data~~ (Figure 1, Appendix). Treatment of ~~has suggested that~~ NHAs~~a~~ with the chemical inhibitor of ~~the~~ ERK ~~pathway~~, U0126, does not reduce JCPyV infectivity in primary astrocytes like it does in SVG-A cells, suggesting that ERK activation may not be required for JCPyV infection in primary cells. However, chemical inhibitors like U0126 have potential off-target effects on cells, and thus it is necessary to use more specific methods to test the role of ERK in JCPyV infection in NHAs. Therefore, employment of siRNA ~~targeted towards~~to knockdown expression of ~~of~~ ERK, will be used to determine whether ERK expression is reduced in NHAs, and ~~with~~ SVG-A cells will be



- Fellowships and Scholarships
- Travel Grants
- Student Symposium
- Faculty Fellows

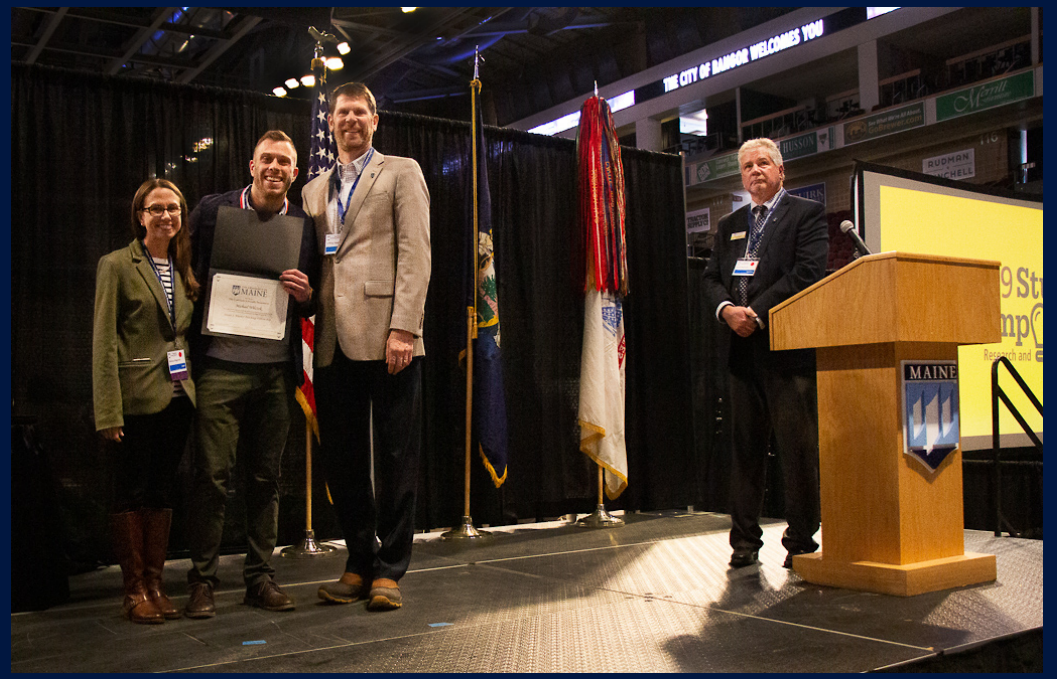
CUGR
CENTER FOR
UNDERGRADUATE RESEARCH
CREATING KNOWLEDGE. PROMOTING SCHOLARSHIP. INSPIRING CREATIVE ACTIVITY.

Generating a Culture that Supports Undergraduate Research Experiences



1st Year Phage Genome Discovery Student

MAINE Student Symposium
Research and Creative Activity



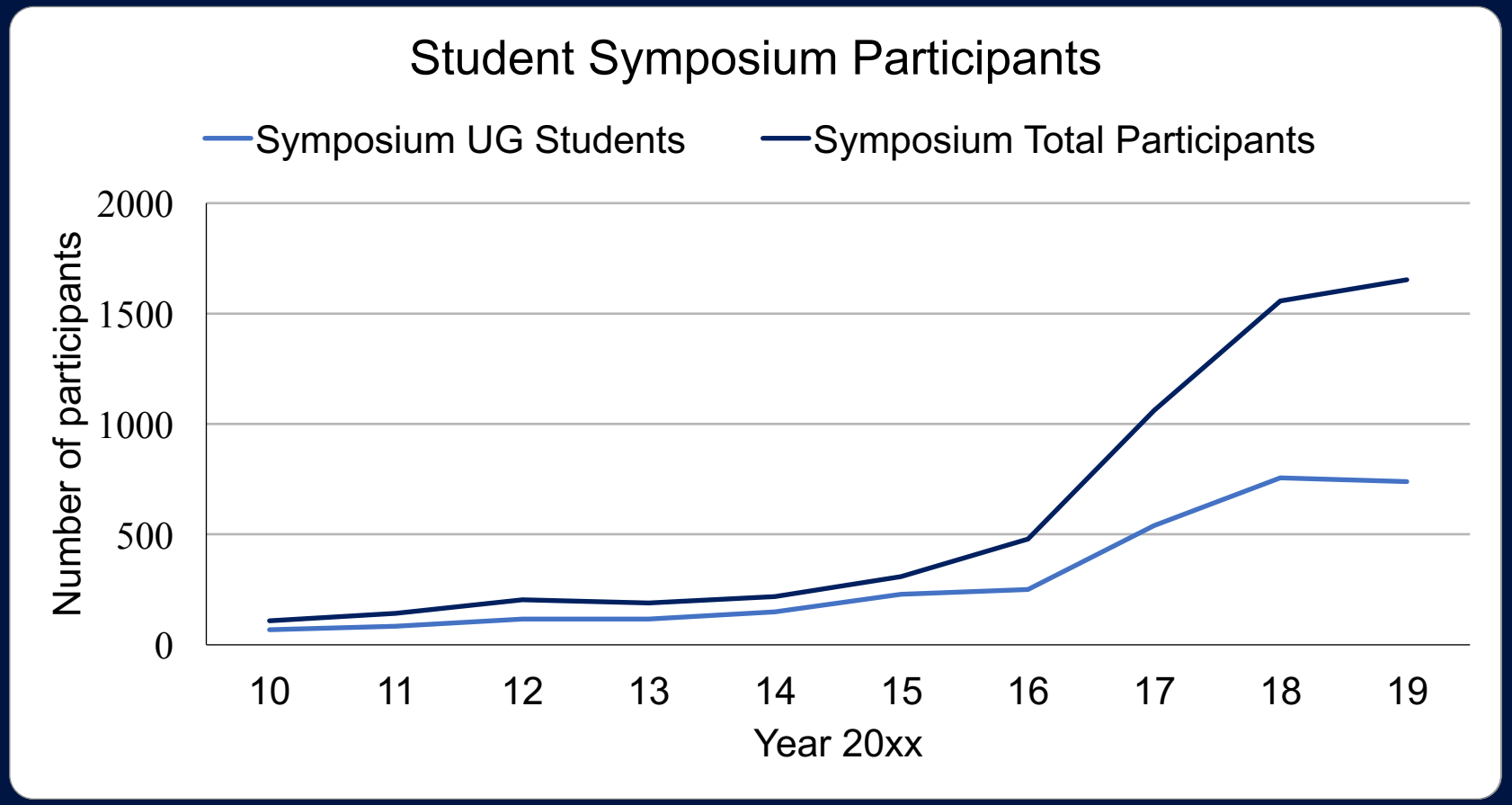
Student Presentation Award Winner

- Fellowships and Scholarships
- Travel Grants
- Student Symposium
- Faculty Fellows

Generating a Culture that Supports Undergraduate Research Experiences

- Started in 2010 as UG Showcase
- Merged with Grad Expo in 2016

MAINE Student Symposium
Research and Creative Activity



Fellowships and Scholarships

Travel Grants

Student Symposium

Faculty Fellows

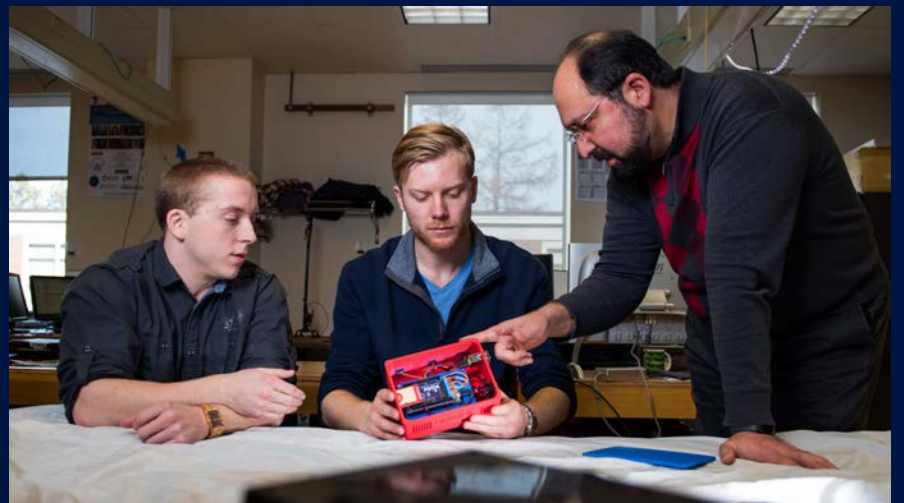
CUGR Impacts on Career Development

Ashley Soucy, *CUGR Fellowship Recipient*

- B.S. Biochemistry ‘18
- 6 fellowships, $15,000 in funding
- Best Undergraduate Presentation in Biomedical Sciences (UMSS18)
- Presented at regional and national conferences
- Co-authored publication
- Currently a PhD student in GSBSE Program

Casey Clark, *CUGR Fellowship Recipient*

- Summer internship as HS student
- B.S. ‘14 and M.S. ‘16 in Electrical Engineering
- Presented at national conferences
- Co-authored publications
  Launched product to international space station
- Currently employed at SpaceX in CA



Recap and Inspire Action

- Pre-college level:
  - Engage with K-12 students
  - Tours, programs, and community engagement
  - Programs to support K-12 educators

- In the classroom:
  - Develop research learning experiences
  - Start pilot programs then build capacity
  - Attract top students

- Institutional-level:
  - Student fellowship opportunities
  - Highlight accomplishments: student research showcase, awards, media
  - Faculty support for undergraduate research
  - Develop centralized programs

Acknowledgments

- Maine INBRE Award P20GM103423
- Maine Economic Improvement Fund

Questions and Discussion

Contact Information:

Joan Ferrini-Mundy: joan.ferrinimundy@maine.edu

Ali Abedi: ali.abedi@maine.edu

Mauricio Pereira Da Cunha: mdacunha@maine.edu

Sally Molloy: sally.dixon@maine.edu

Melissa Maginnis: melissa.maginnis@maine.edu

CUGR
CENTER FOR
UNDERGRADUATE RESEARCH
CREATING KNOWLEDGE. PROMOTING SCHOLARSHIP. INSPIRING CREATIVE ACTIVITY.

1865 THE UNIVERSITY OF MAINE