

# Data Visualization Tools for High School Teachers

Day 1

# Before We Begin

## Pre-workshop notes



Use headphones



Everyone their own laptop



Quiet space



Reliable internet connection



Camera on

## online etiquette



Mute yourself



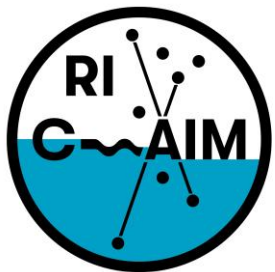
Press spacebar to unmute



Want to speak



Yes / agree



RHODE ISLAND CONSORTIUM FOR  
Coastal Ecology  
Assessment  
Innovation &  
Modeling



This material is based upon work supported in part by the National Science Foundation under EPSCoR Cooperative Agreement #OIA-1655221

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

# Today's Agenda

- 9:00 - 9:15: Who are we? And who are you?
- 9:15 - 9:30: RI C-AIM work
- 9:30 - 9:55: Data Visualization tools
- 9:55 - 10:00: Break
- 10:00 - 10:55: Guest Speaker: Dr. Helen Flavin
- 10:55 - 11:00: Break
- 11:00 – 11:45: SimplechartsRI.com
- 11:45 – 12:00: Discussions and expectations for day 2

# Who are we?



Dr. Anabela Maia



Dr. Sally Hamouda



Sean Khang



Jovan Dias



Cinthia Santos Gil and Domingo Lora

Who are you?

What is your  
experience with data  
visualization?

What are your  
expectations?



Gina Cunha  
Don Lurgio  
Amy Kizzee



Shannon Donovan  
Joel Swan



Elizabeth Letourneau  
Mark Davis



Justin Kuncz  
Helaine Hager



Kelly Reese  
Whitney Biafore

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# 5 Minutes Break!

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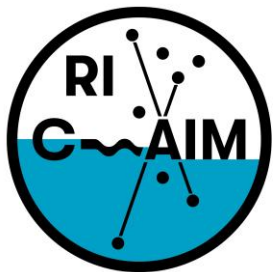
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# Guest Speaker

**Dr. Helen Flavin**

## **"The Power of Data Visualization in NGSS Sciventures"**

Dr. Flavin is a Scientist and Educator. She received her Ph.D. in Neurochemistry from Boston College. Her Postdoctoral research at Yale Medical School studied modulation of neuronal communication in the developing visual cortex.

Dr. Flavin's direct classroom experience includes Grade 6 through College. Courses taught span both the Biological and Chemical Disciplines. She has designed a Forensics and Molecular Biology High School curriculum. Dr. Flavin has been active in NGSS curriculum redesign at the High School and Middle School Levels.



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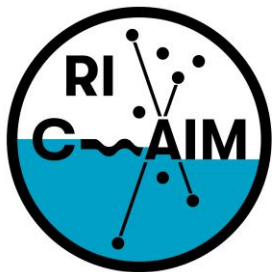
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# RI C-AIM Work



[Best Practices Workshop](#)



[Teacher Activity Book](#)



[Student Activity Book](#)



[SimpleChartsRI](#)



[Publications](#)

# Data Visualization Tools



Excel and Google Sheets



Power BI



Tableau



Piktochart



Infogram

# Data Visualization Tools

Did you use any of it?



Excel and Google Sheets



Power BI



Tableau



Piktochart



Infogram

# Excel and Google Sheets

- These are probably the most common programs you will use
  - The following programs even accept uploads from them
- Google Sheets is free and allows for easier collaboration
  - It's user-friendly
- Excel is great with big data, but generally requires training on how to utilize its full capabilities
  - Office 365 does allow collaboration between users now

The top screenshot shows a Google Sheet titled 'Categories.xlsx'. It contains a table with the following data:

Categories	Dataset Name	Dataset Source	Simple?	Complex?	
Natural Disasters	Top Ten States Tornadoes 2017	<a href="https://www.lli.org/fact-statistic/facts-statistics-tornadoes-and-thunderstorms">https://www.lli.org/fact-statistic/facts-statistics-tornadoes-and-thunderstorms</a>			
	Earthquakes in RI	<a href="https://earthquake.usgs.gov/earthquakes/map/?extent=40.93841,-73.24036&amp;extent=42.38898,-69.72473&amp;range=search&amp;baseLayer=terrain&amp;timeZone=utc&amp;search=%7B%22name%22:%22Search%20Results%22,%22params%22:%7B%22url%22:%22https://www.tandfonline.com/doi/figure/10.1080/19475705.2011.632443?scroll=top&amp;needAccess=true">https://earthquake.usgs.gov/earthquakes/map/?extent=40.93841,-73.24036&amp;extent=42.38898,-69.72473&amp;range=search&amp;baseLayer=terrain&amp;timeZone=utc&amp;search=%7B%22name%22:%22Search%20Results%22,%22params%22:%7B%22url%22:%22https://www.tandfonline.com/doi/figure/10.1080/19475705.2011.632443?scroll=top&amp;needAccess=true</a>			
	Tsunamis in Japan	<a href="https://www.ncdc.noaa.gov/snow-and-ice/sno">https://www.ncdc.noaa.gov/snow-and-ice/sno</a>			

The bottom screenshot shows a Microsoft Excel spreadsheet titled 'Employee attendance tracker - Excel'. It features a complex table with columns for 'Last Name', 'First Name', 'Vacation', 'Personal', 'Sick', 'SSN', 'Position', 'Supervisor', 'Hire Date', 'Comments', 'Vacation Days per Year', and 'Vacation Days Remaining'. A tooltip is visible over the 'Sick' column, stating: 'Number of Sick leave is automatically updated in this column under this heading.'

# Power BI



- A Microsoft product for businesses to make interactive data visualizations
- Has guided learning and a free 4-week course
  - Also has a free downloadable version where you can make Power BI reports or publish them on their website
- Requires a Windows operating system; to collaborate on one project you need to pay for a Power BI Pro license
- Only 501c organizations receive discounted/donated software; schools with at least 1,000 possible student users can apply for the Enrollment for Education Solutions (EES)

# What can it do?



- Power BI says its strength is making complex data more comprehensible, which leads to data-driven decision-making
- Power BI can create all types of visualizations using a drag-and-drop method
- Let's take a look at Power BI's featured Dashboard (how visualizations are presented to others)



<https://community.powerbi.com/t5/COVID-19-Data-Stories-Gallery/COVID-19-Dashboard-From-Data-to-Insights/td-p/995011>



# How can I get it?



<https://www.microsoft.com/en-us/download/details.aspx?id=58494>

Link to free download

### Choose Power BI Pro

- Self-service and modern BI in the cloud
- Collaboration, publishing, sharing, and ad-hoc analysis
- Fully managed by Microsoft

### Add Power BI Premium

- Enterprise BI, big data analytics, cloud and on-premises reporting
- Advanced administration and deployment controls
- Dedicated cloud compute and storage resources
- Allows any user to consume Power BI content

#### Power BI Pro

**\$9.99**

Monthly price per user

[Buy now >](#) [Try free >](#)

#### Power BI Premium

**\$4,995**

Monthly price per dedicated cloud compute and storage resource with annual subscription

[Request a consultation >](#)



# Tableau

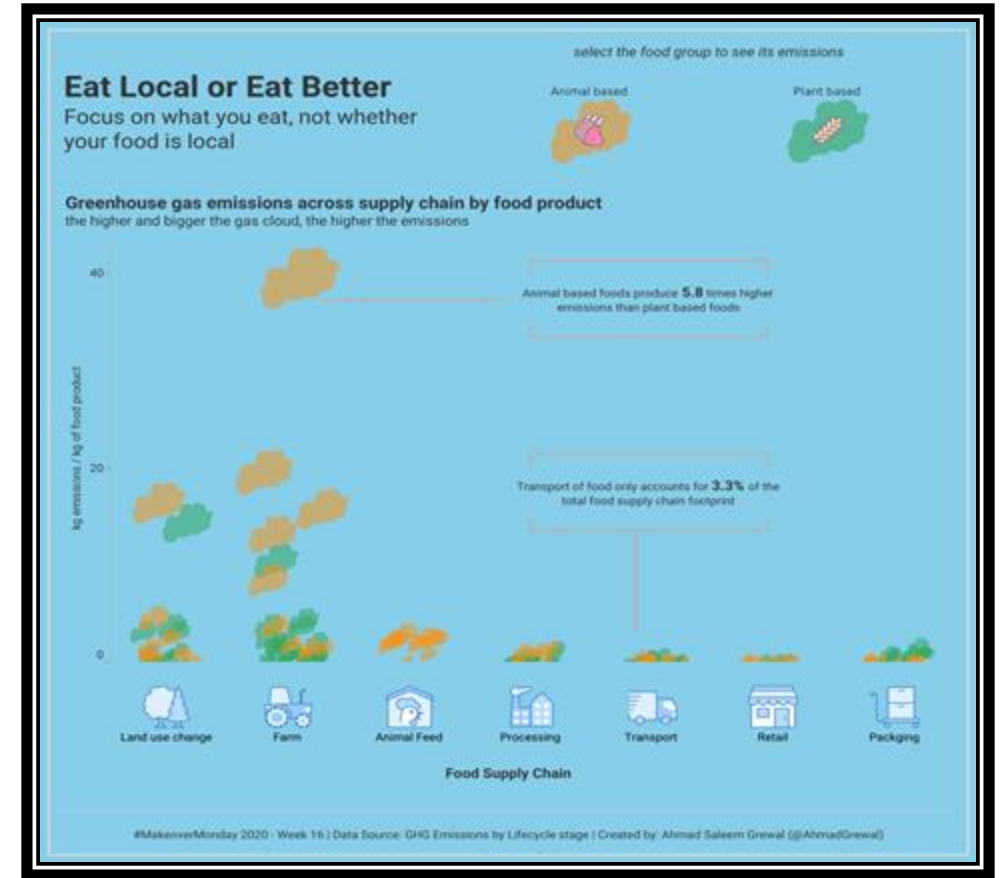


- Designed for professional use, has hours and hours of training videos
- Once verified, teachers and students get free copies of the software to use
  - The instructor resource page even has ready-made course materials, ways to contact other teachers using Tableau, a free guidebook for students, and a knowledge base for FAQs
- You can even get travel grants to go to academic conferences!

# What can it do?



- Mission Statement: We help people see and understand data
  - Very true for people that see the end product!
- Learning to use Tableau or Power BI is no light undertaking
  - Tableau can handle big data for big businesses
- It will take a long while to be able to utilize either program to the most of its capabilities
- We can take a look at Tableau's featured content here



# How can I get it?



<https://www.tableau.com/academic/teaching/course-licenses>

Link to request free software

## Tableau Creator

\$70

USD/user/month  
billed annually

Discover insights faster by combining a powerful suite of products for visual data prep, best-in-class analytics, and secure collaboration to support your end-to-end analytical workflow.

Buying for one person has  
just the one option

Buying for a team has  
several options available

DEPLOY WITH TABLEAU SERVER  
On-premises or Public cloud

DEPLOY WITH TABLEAU ONLINE  
Fully hosted by Tableau

### Tableau Creator

Every deployment requires at least one Creator

\$70

user/month | billed annually

Discover insights with a powerful suite of products that support your end-to-end analytics workflow.

### Tableau Explorer

\$35

user/month | billed annually  
min. 5 Explorers required

Explore trusted data and answer your own questions faster with full self-service analytics.

### Tableau Viewer

\$12

user/month | billed annually  
min. 100 Viewers required

View and interact with dashboards and visualizations in a secure, easy-to-use platform.

# Piktochart



- A way to make infographics, flyers, presentations, reports, or posters
- For academic use, Individual PRO plans cost \$40 per person and PRO Team plans cost \$200 a year
  - You need the team plan to allow for design collaboration
- The free version lets you make 5 visualizations
- You can download your work as a PNG (free version), or as a PDF or PowerPoint (paid versions)
  - You can also share your visualization publicly for free, and get a link for people to view it



## COURSE EXPECTATIONS

**P**REPARED  
Be prepared, focused and ready to learn something new in every class.

**R**ESPONSIBLE  
Make sure you make the most of class time and study time. Class attendance is also important to help students understand content.

**P**ROACTIVE  
Engagement and participation in class is highly encouraged. Don't be afraid to share your thoughts or ask for clarification!

**R**ESPECTFUL  
Be respectful towards the professor and your classmates. Encourage one another and stay united as a team!

## OFFICE HOURS



Fogarty Room 247  
Phone: 401-456-9071  
oresendedamaia@ric.edu



Tuesday 1-2pm, Wednesday 3-4pm  
or by email appointment



## CLASSROOM PHILOSOPHY

Come prepared, leave with a deeper understanding of how the human body works.

## HOW TO SUCCEED IN THIS COURSE

Keep up with the lecture material.



Study in group and explain hard concepts to others to check for understanding.



Ask the professor about learning strategies specific for this class



Study at least 10 minutes everyday.



Attend office hours, open labs and review sessions



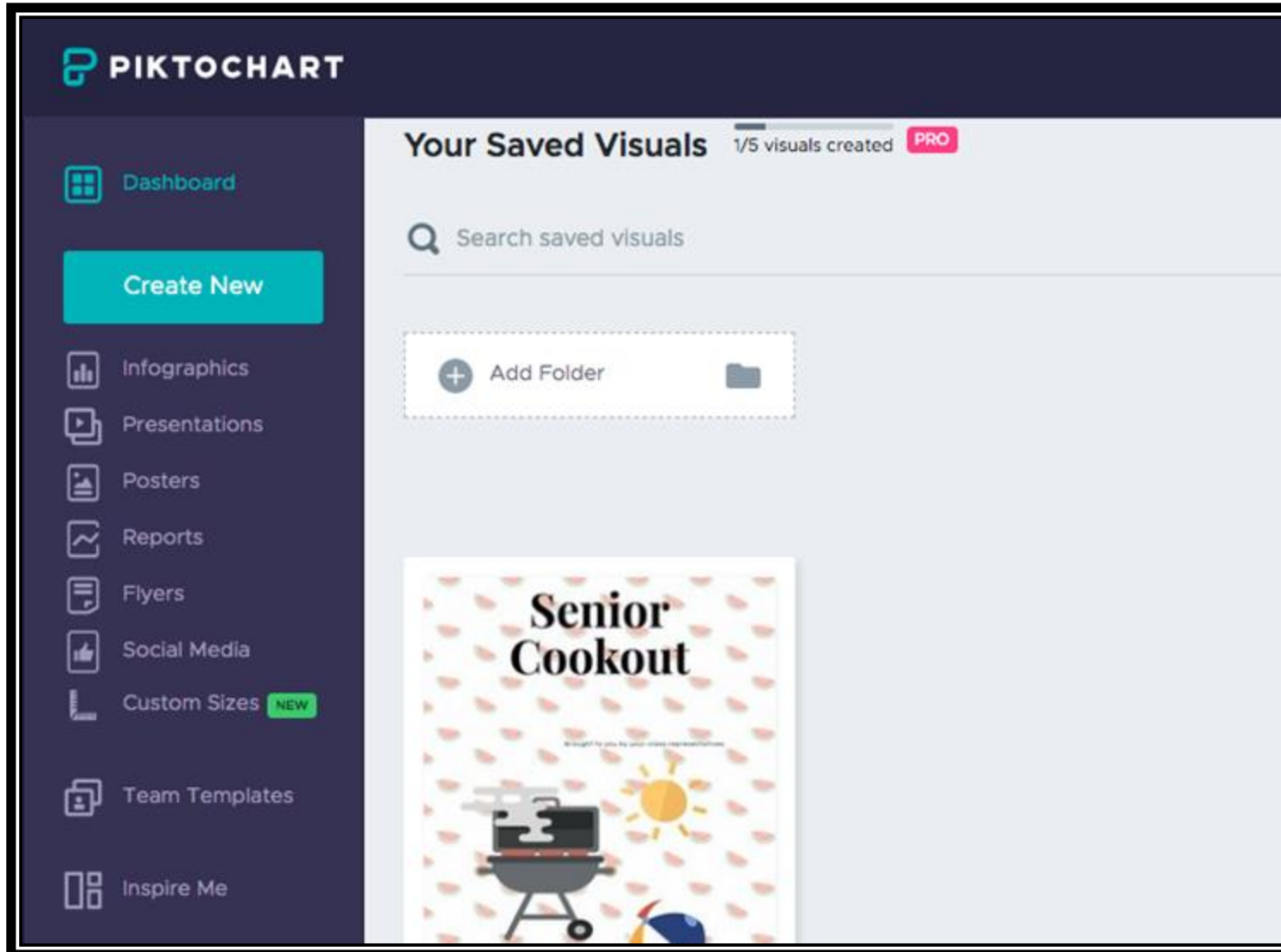
Make use of the Bio tutoring



## Dr. Maia's Syllabus

- A different approach
- More engaging than a traditional syllabus layout

# How does it work?



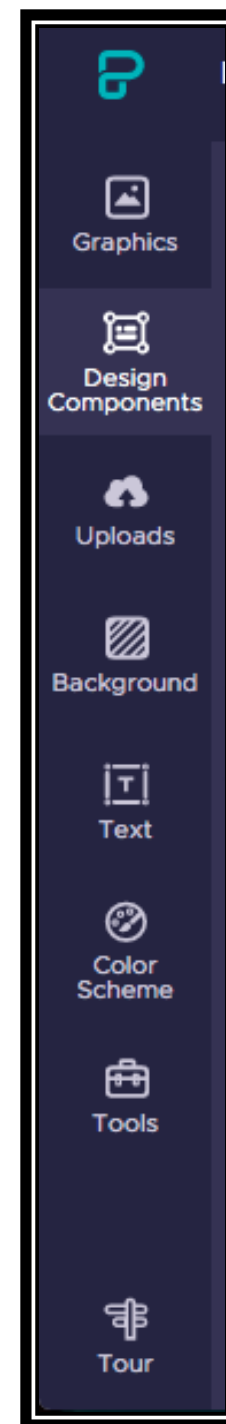
## The Dashboard

- Shows your previous work
- List of options on the side brings up relevant templates
- Create New brings up the list of options with a short description for each one

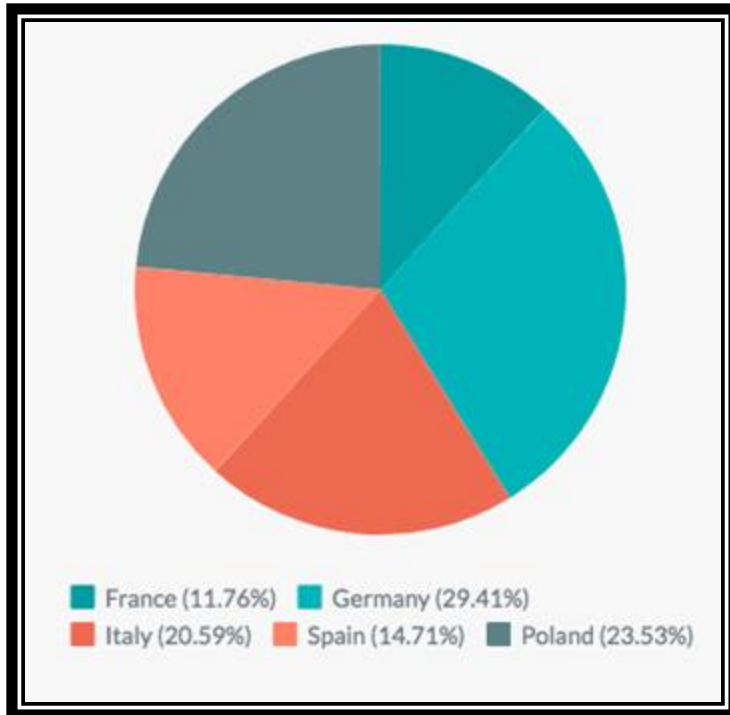
# How does it work?

## The Toolbar

- Pretty much every tool is self-explanatory
- Graphics has icons, lines, photos, and other stylistic elements
- Design Components allows for the specific block types that essentially make up each project
  - Lists, Timelines, and Comparisons
- Tools has your Charts, Maps, and Video options
  - For charts, you can edit the data in the software, upload your data, or make dynamic data by inserting the Google Sheets link
  - Watch out for some of these charts! They do not follow the best practices



# What to look out for



Incorrect ordering on pie charts (you will have to order it yourself in the data)

Odd shapes lead to confusion





# 5 Minutes Break!

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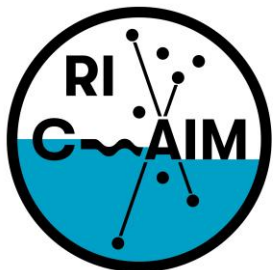
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Want to speak



Yes / agree



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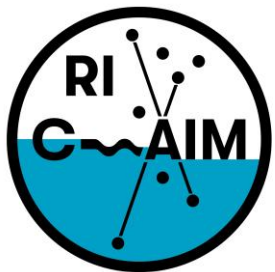
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# SimpleChartsRI.com

## Create a Chart in 3 Steps

1

### Choose Data

Pick a sample, upload a file, or create some data in a table.

2

### Select Chart

Choose which chart type best represents your data.

3

### Customize

Title your chart, label each axis, and change its color scheme.

Create a Chart

# SimpleChartsRI.com

## SimpleChartsRI Demo



[Home](#) [Resources](#) [About](#) [Contact](#) [Rate Us](#) [Help](#)

### 3) Customize & Interact

Click & drag on the chart to pan. Scroll to zoom. Hover over chart elements to see their respective values. Hover over datasets in the legend to bring them into focus, or click them to hide/show them.

Chart Title

RI College and University Tuition

X-Axis Label

School

Y-Axis Label

Amount

Color Style

Pick a color style

Hide Legend

Horizontal

Stacked

Dataset

Tuition In-State

Dataset's Chart Type

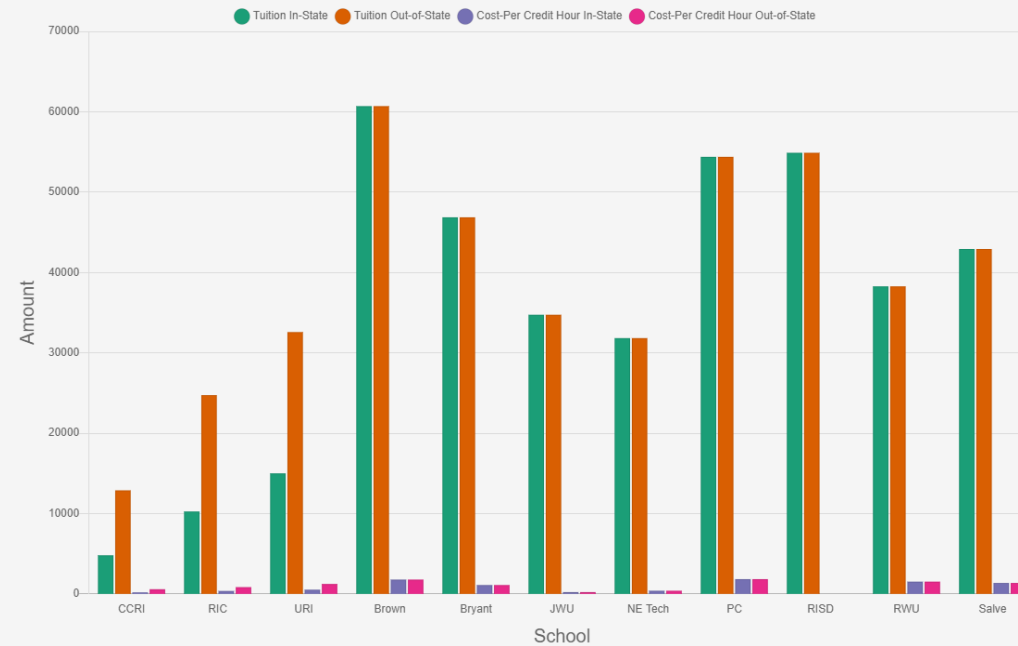
Bar

Chart Type for All Datasets

Bar

Edit Chart Data

### RI College and University Tuition



Reset Zoom

# SimpleChartsRI.com

## SimpleChartsRI Evaluation

 SimpleChartsRI

Home Resources About Contact [Rate Us](#) Help

### 1) Choose Data

Formatting matters. The quality of a visualization can only ever match the quality of its data.

[Choose Sample](#)

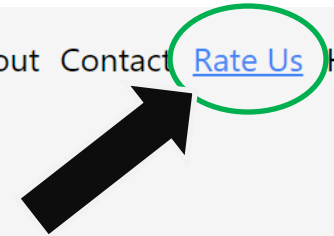
[Create Data](#)

[Upload File](#)

Click on a sample from our simple or complex datasets to see how SimpleChartsRI can help you visualize data!

[Simple Datasets](#)

[Complex Datasets](#)



# Day 2 Expectations

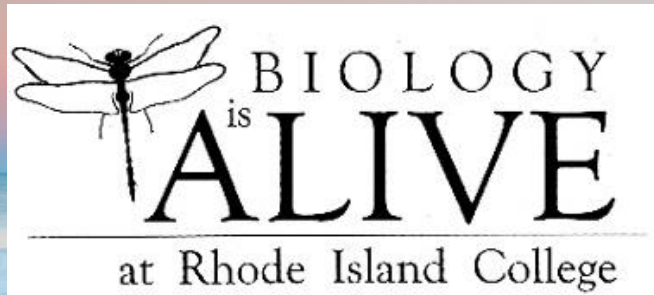
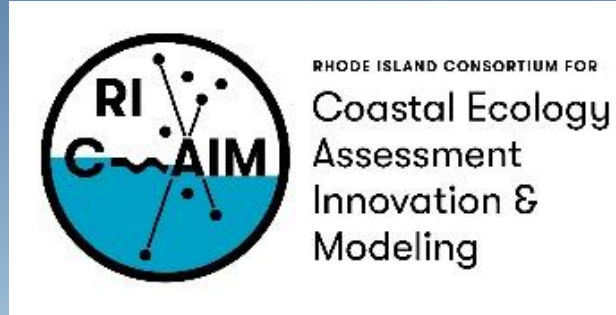
- Learning more in depth about infogram: how it works, how to use it and practice using it





**Thank you!**  
**Any Questions?**  
**End of Day 1**

REACH  
INSPIRE  
CONNECT



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Rhode Island College

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[@AnabelaM](https://twitter.com/AnabelaM)

<http://maialabric.wordpress.com>







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# RI C-AIM Who we are?












## The Rhode Island Consortium for Coastal Ecology Assessment, Innovation and Modeling

RI NSF EPSCoR Award #OIA-1655221



@RIEPSCoR

 <p><b>THE UNIVERSITY OF RHODE ISLAND</b></p> <p>University of Rhode Island RI C-AIM lead institution</p> <p>VISIT →</p>	 <p><b>BROWN</b></p> <p>Brown University data management, ocean modeling</p> <p>VISIT →</p>	 <p><b>BRYANT UNIVERSITY</b></p> <p>Bryant University marine food webs, microbial dynamics</p> <p>VISIT →</p>	 <p><b>PROVIDENCE COLLEGE</b></p> <p>Providence College species identification, visualization</p> <p>VISIT →</p>
 <p><b>RHODE ISLAND COLLEGE</b></p> <p>Rhode Island College microbiological modeling, workforce development</p> <p>VISIT →</p>	 <p><b>RHODE ISLAND SCHOOL OF DESIGN</b></p> <p>Rhode Island School of Design data visualization, graphical research translation</p> <p>VISIT →</p>	 <p><b>Roger Williams University</b></p> <p>Roger Williams University microplastics detection, undergraduate research training</p> <p>VISIT →</p>	 <p><b>SALVE REGINA UNIVERSITY</b></p> <p>Salve Regina University microfluidic systems, planktonic diversity characterization</p> <p>VISIT →</p>

# RI C-AIM



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THE  
UNIVERSITY  
OF RHODE ISLAND

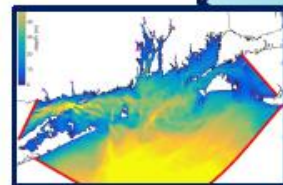


Assessing Biological and  
Ecosystem Impacts (RT1)

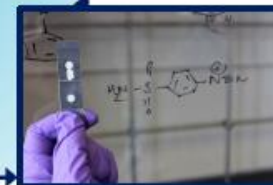


**3 Research Thrusts (RT)**  
guide collaborative, cross-  
institutional project teams

**4 Inter-Thrusts (IT)** span,  
support, guide, and  
leverage Research Thrusts



Predicting Ecosystem  
Response (RT2)



Enabling Technologies for  
Improved Detection (RT3)



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# RI C-AIM Inter Thrusts



**Educational initiatives** are incorporating RI C-AIM research into college-level courses and senior capstone projects



**SURF & SURF+** are paid programs that provide undergraduates with first-hand experience in research

## IT3 – Stakeholder engagement



**Visualization and Imaging (IT 1)** Across thrusts, RI C-AIM is developing novel approaches to visualization of scientific observations in complex ecosystems through collaborations between engineers, designers, artists and oceanographers, thus fostering greater understanding from industry leaders, policy makers and the public.

## IT2 – Workforce Development and Increasing representation in STEAM



**Diversity Action Committee (DAC):** Resources for students and faculty to achieve inclusive collaborations



**Career Development:** RI C-AIM offers many opportunities in research and professional skills training

## IT1 – Visualization and Imaging

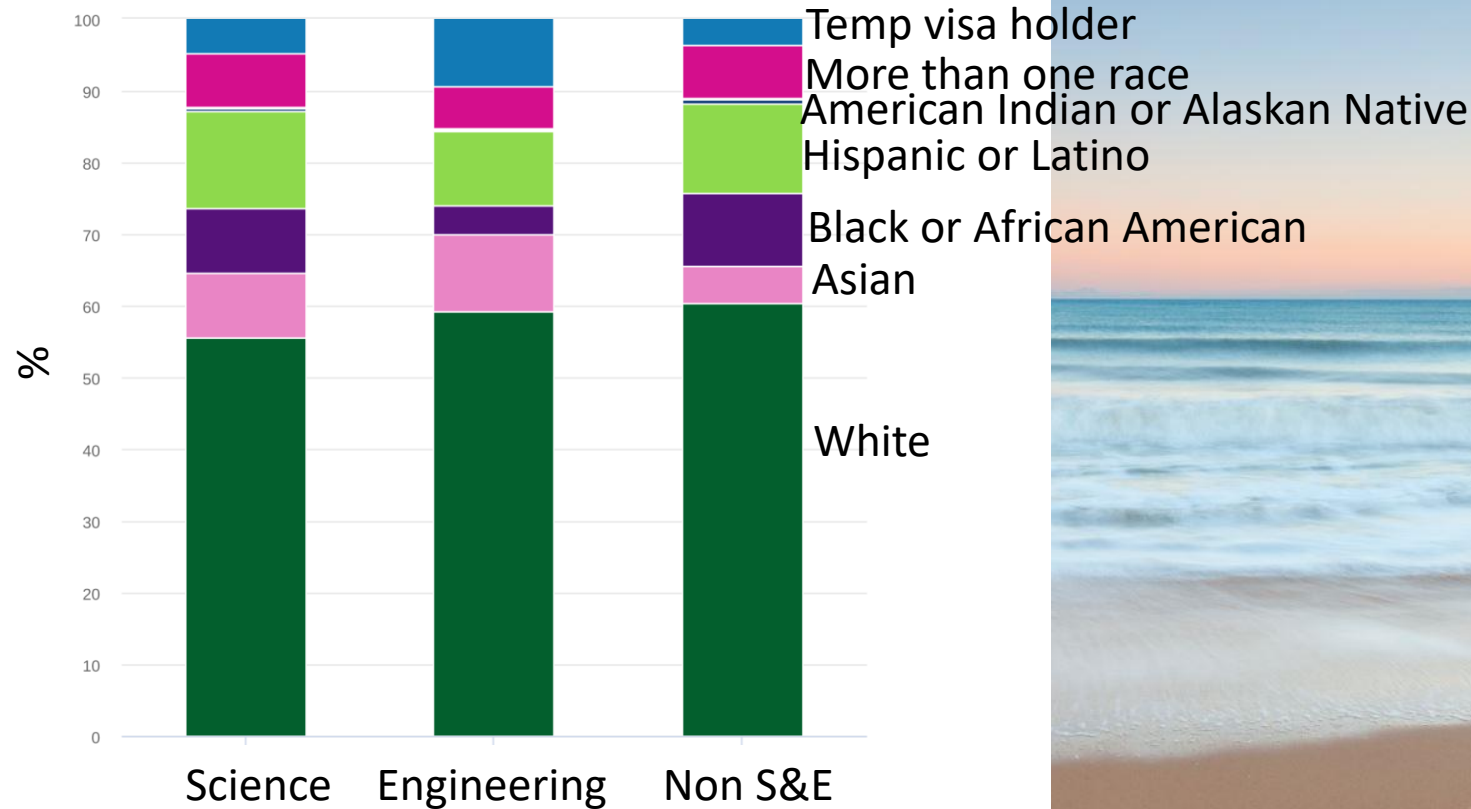


Scientists and graphic artists are coming together to develop media which help explain research in stimulating and novel ways.

# Empowering and Recruiting URM



Bachelor's degrees earned by ethnicity, race and citizenship in 2016 (source NSF)

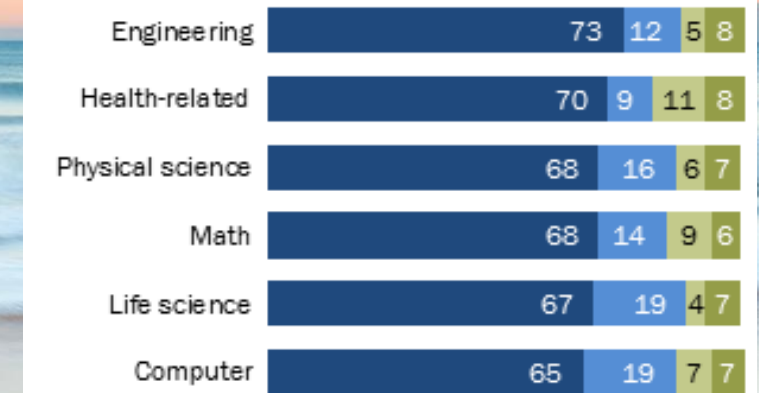


## Blacks and Hispanics underrepresented across most STEM job clusters

% of employed in each occupational group who are ...



Among those who work in \_\_\_ jobs



Note: Based on employed adults ages 25 and older. Whites, blacks and Asians include only non-Hispanics. Hispanics are of any race. Other and mixed race non-Hispanics are not shown. Engineering includes architects. STEM stands for science, technology, engineering and math.

Source: Pew Research Center analysis of 2014-2016 American Community Survey (IPUMS).

"Women and Men in STEM Often at Odds Over Workplace Equity"

# RI Data Discovery Center

- One Place, real time (and historic) data

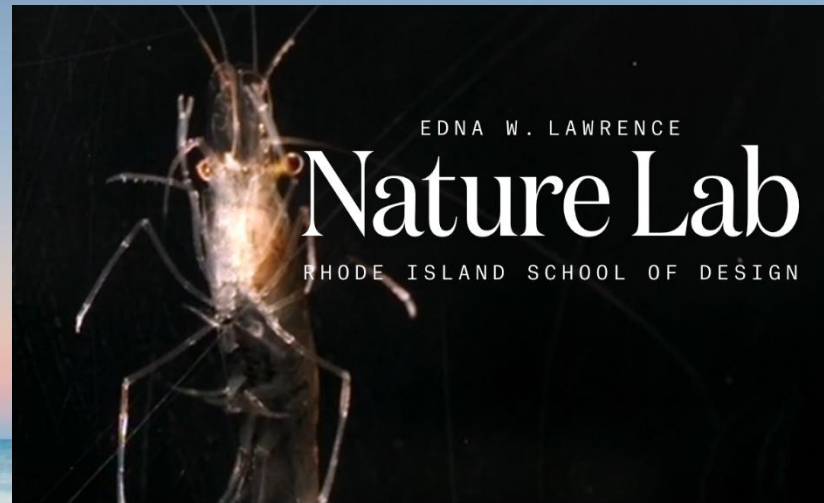
<https://ridatadiscovery.org/#/>





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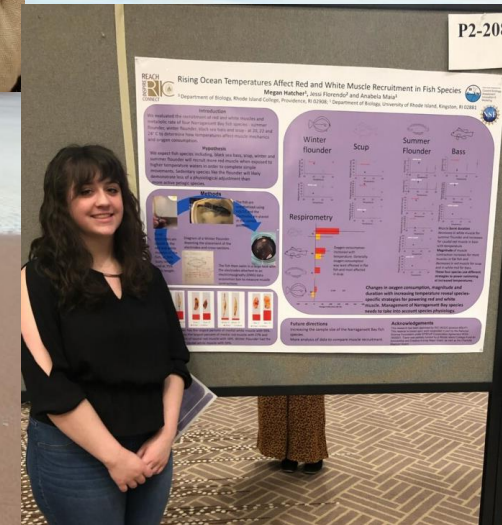
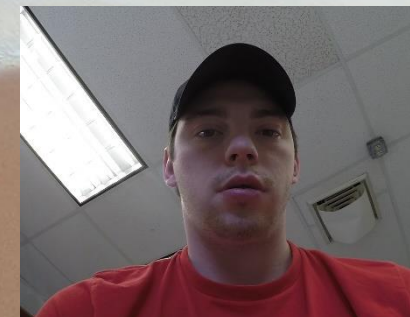
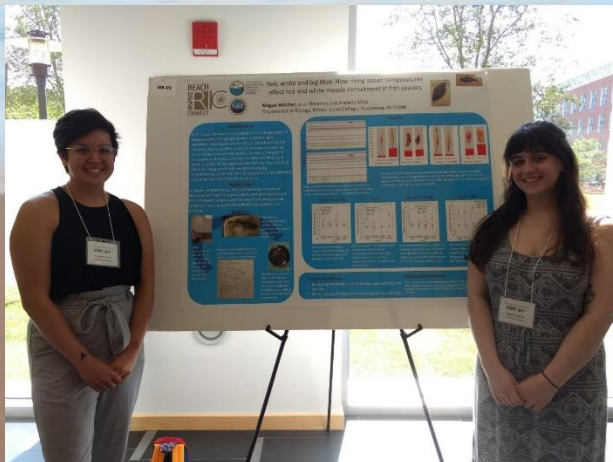
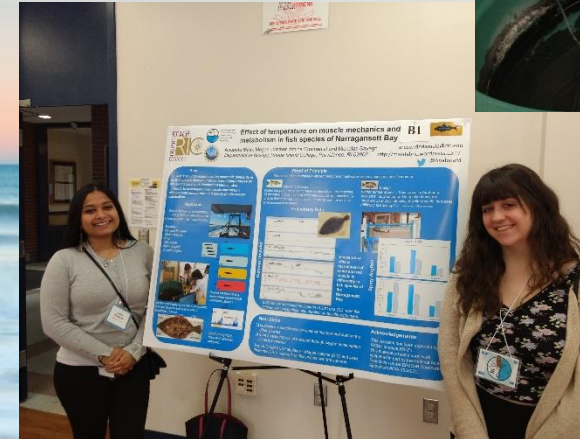
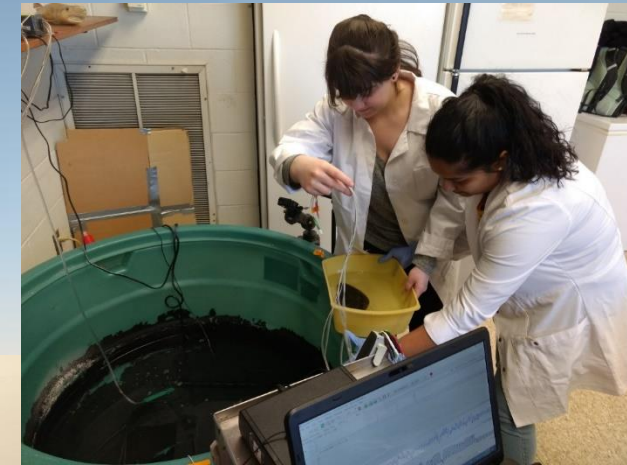
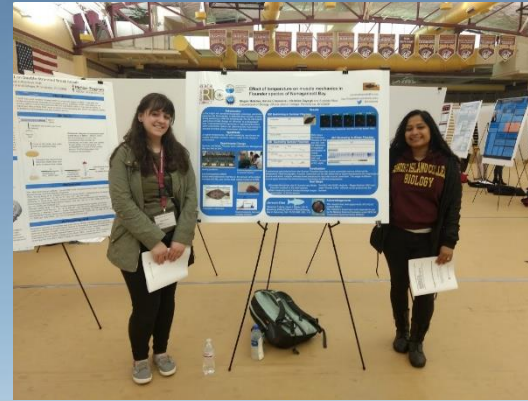
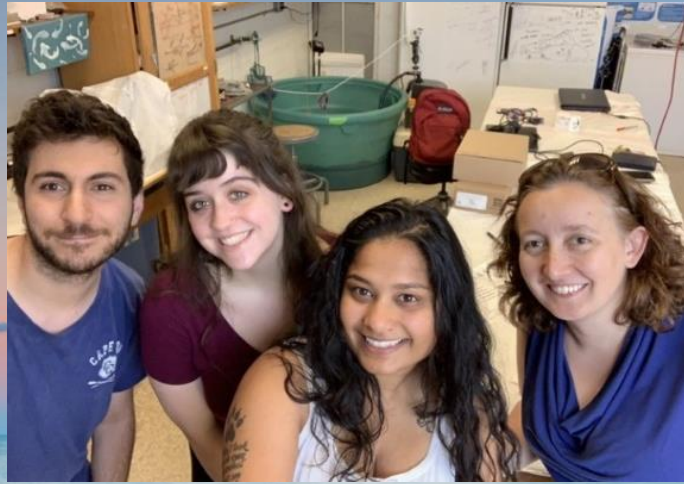
# RI C-AIM Core Facilities

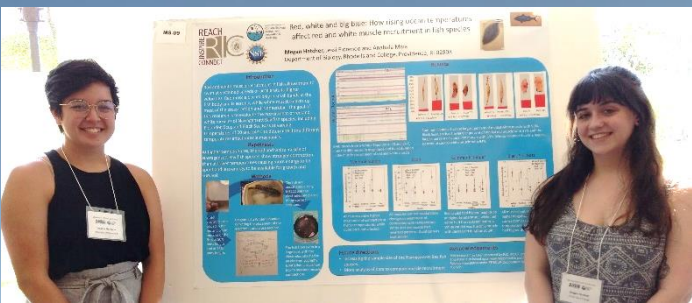
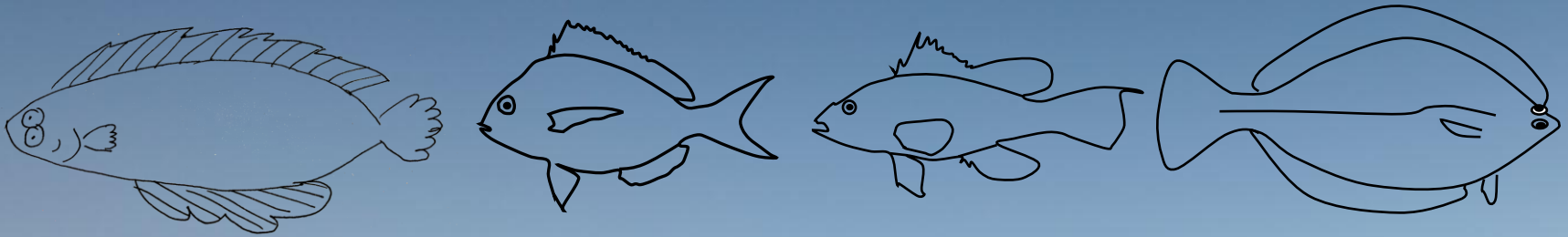


# RI C-AIM at RIC



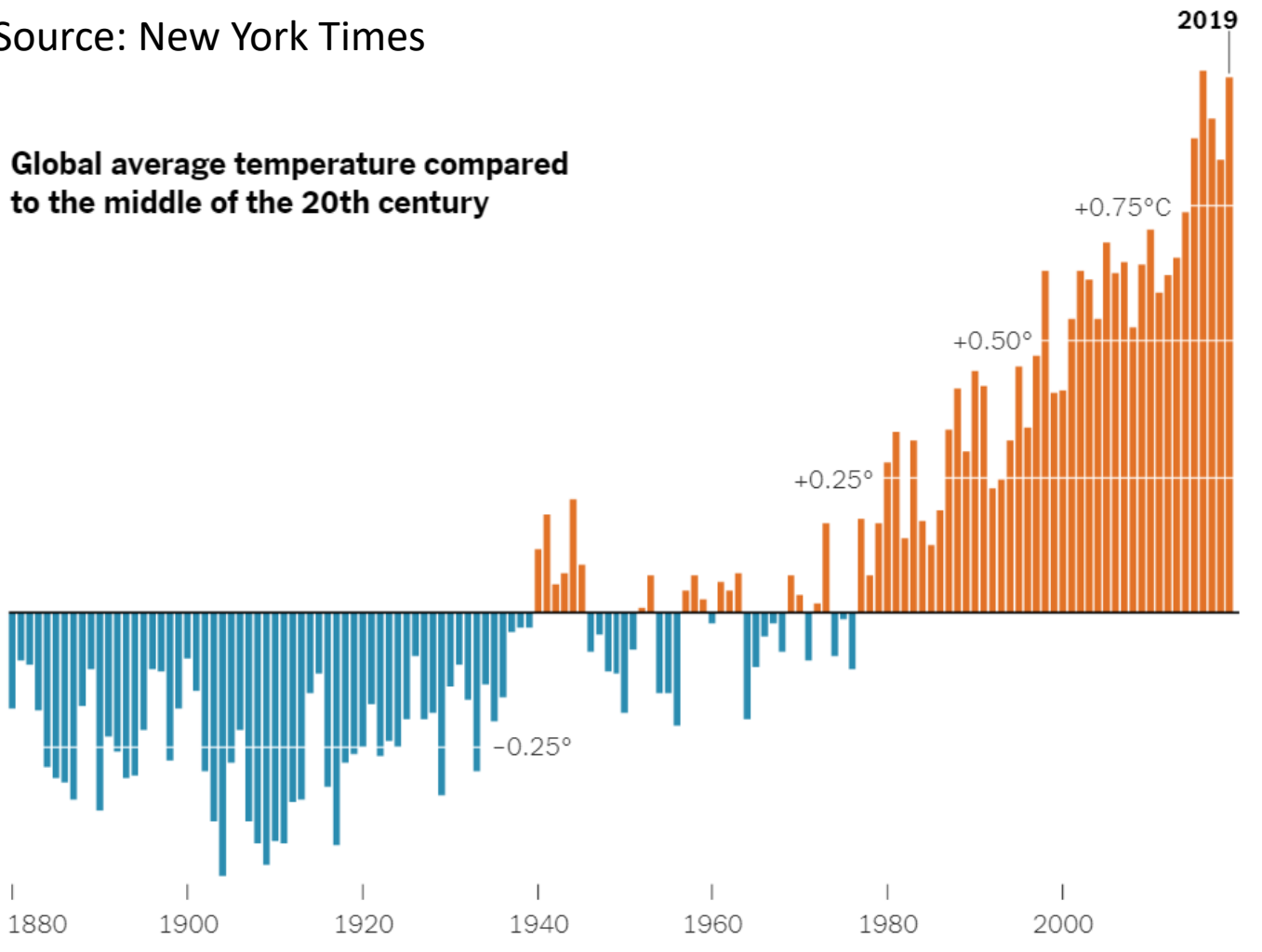
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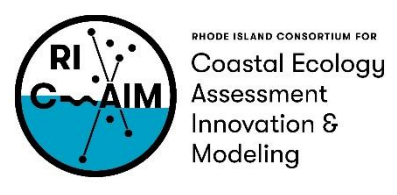
Source: New York Times

Global average temperature compared to the middle of the 20th century



How are fish species of Narragansett Bay affected by rising summer temperatures?

Are muscle mechanics and oxygen consumption limiting factors?

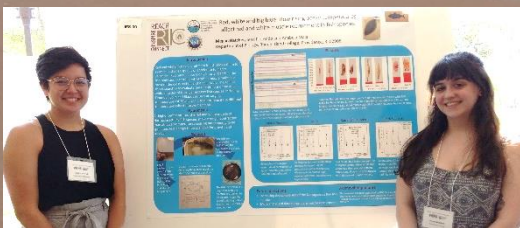
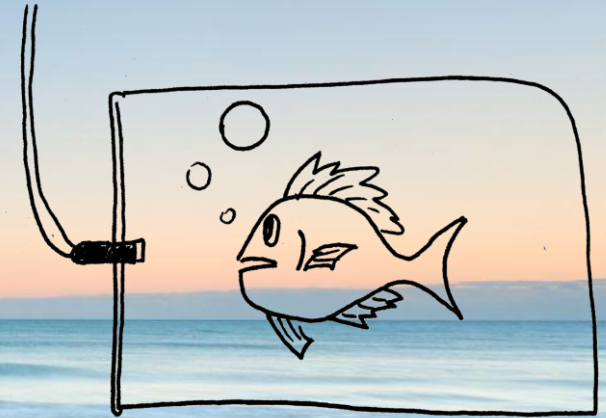
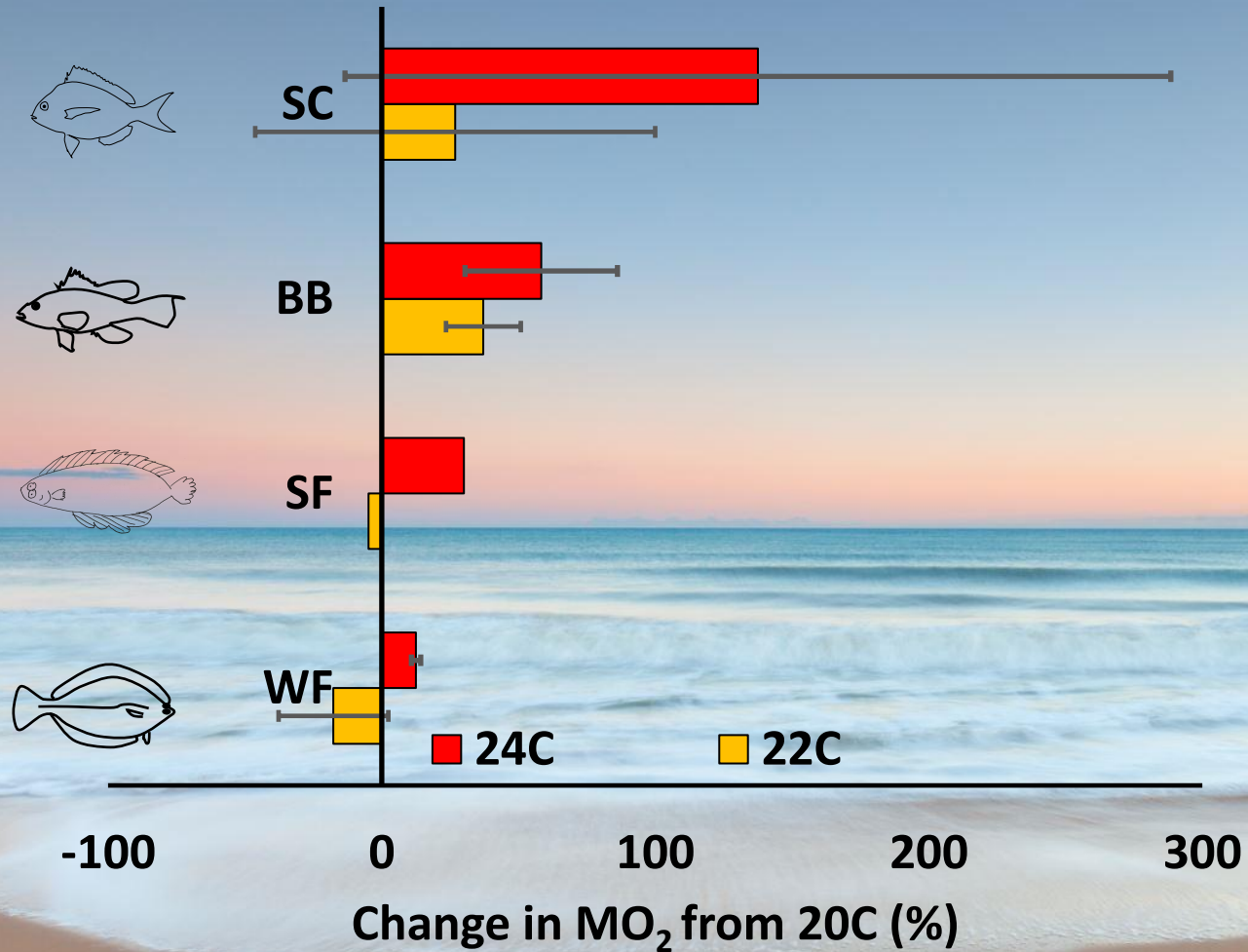


RHODE ISLAND COLLEGE





# Effects of temperature on metabolic rate



Oxygen consumption is less affected in flatfish species.

# Data Visualization in Biology

## Epilepsy



RHODE ISLAND COLLEGE

### What is the **IMPACT** of epilepsy?

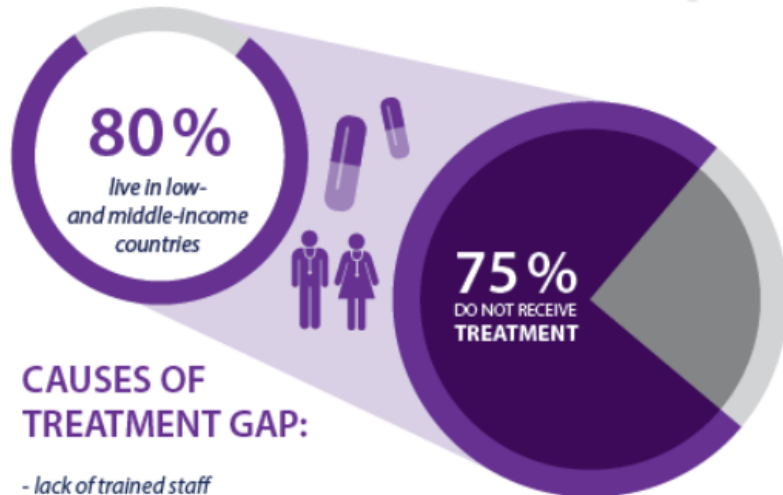
# 50 000 000

More than 50 million people are living with epilepsy globally



# 3-6 TIMES

**GREATER RISK**  
OF PREMATURE DEATH



#### CAUSES OF TREATMENT GAP:

- lack of trained staff
- poor access to anti-epileptic medicines
- societal misconceptions
- poverty
- low prioritization for the treatment of epilepsy



### What is the **SOLUTION**?



# Other Outreach Projects



**Peers 'n' Pubs**  
Science Behind the Scenes

peers 'n' pubs

*Get Hooked on Fin-Tastic Shark Research!*

RESEARCH ARTICLE  
Hydrodynamic function of dorsal fins in spiny dogfish and bamboo sharks during steady swimming

*breaks down this*

**Anabela Maia, PhD** *(she/her)*  
Rhode Island College  
@anabelam

*with the help of her friend*

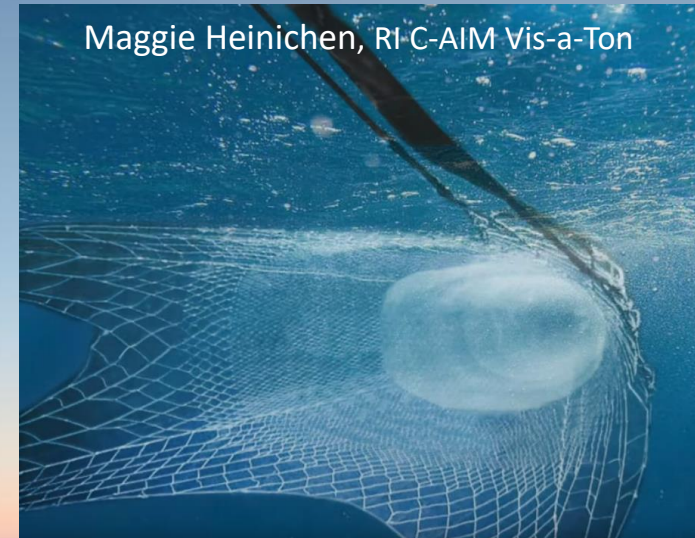
**PROJECT TOMORROW**

**Ren Whitaker** *(she/her)*

**August 15 | 7pm ET/6pm CT/4pm PT**  
**Register: <https://bit.ly/3fMUnjO>**

peersnpubs.org

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**Uma volta  
ao mundo  
com cientistas  
portugueses**

# **RIC Responce Plan**

Perception of success for students with disabilities  
in colleges and universities.

- Cinthia V. Santos Gil

**A**

The historical background between students with disabilities and Colleges and Universities.

**B**

Rhode Island College, campus climate report, with respect to Students with disabilities.

**C**

Expert opinions and areas for further research.

**D**

Proposed Solutions and areas of improvements.

In the decade of the 1980s, there was a rapid increase in the number of students with learning disabilities (LD) attending colleges and universities.

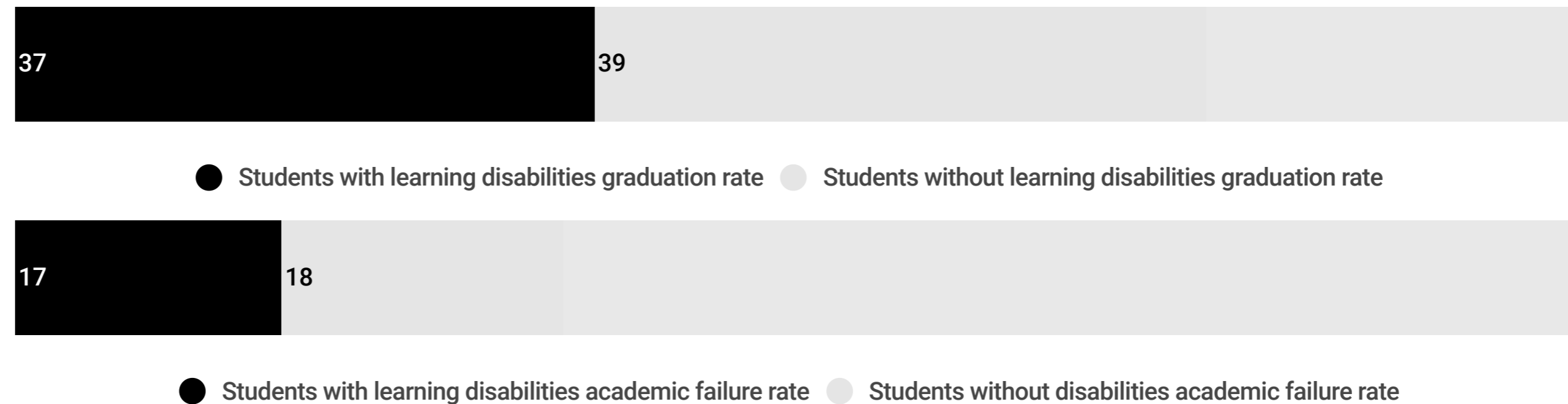
(Astin et al., 1988)

6% of full-time/first-time college students reported having at least one disability, twice the number of students in the previous decade.

(Vogel et al., 1992)

## The history of students with disabilities in Colleges and Universities

- Previous research has identified (a) identify Issues, (b) social stigma, (c) insufficient knowledge, (d) perceived quality and usefulness of services provided, and (e) negative experiences with faculty. As the five major thematic categories serving as barriers that stop students from seeking out and making full use of services and accommodations provided by their respective Offices of Disabilities (ODS). (Marshak et al 2009)

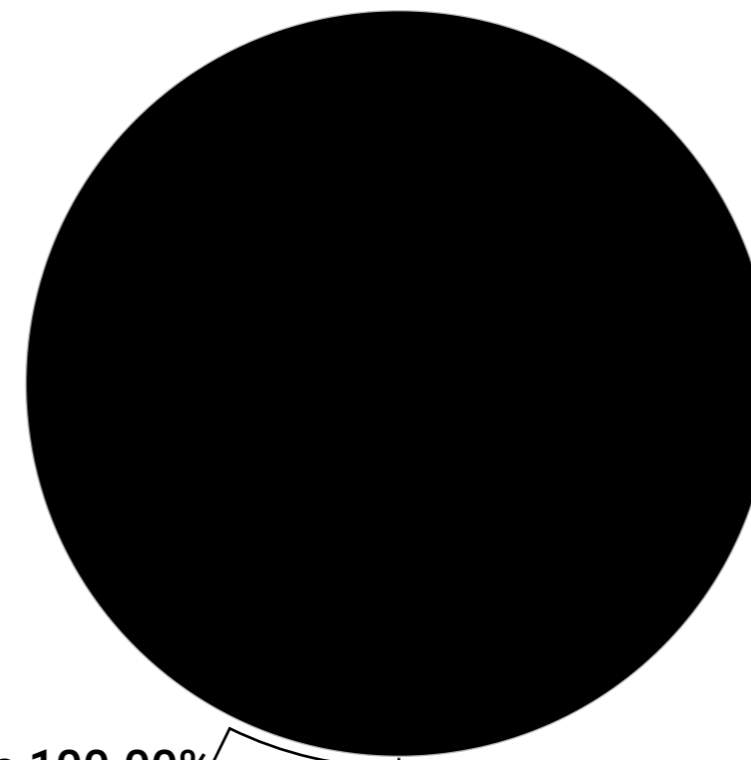
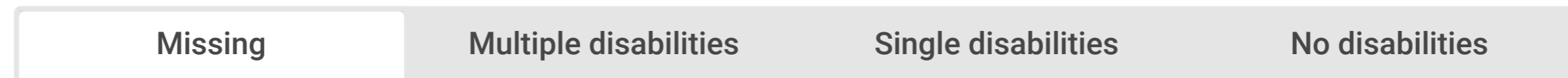


Undergraduate and Graduate Student Respondents with Multiple disabilities were both found to have a lower Perceived Academic Success score than Undergraduate and Graduate Students with no disability. (Ranking et al., 2019)

The final college-wide survey was made up of 118 questions, consisting of 93 quantitative questions and 25 open-ended questions. (Ranking et al., 2019)

Rhode Island College Climate report, with respect to students with disabilities

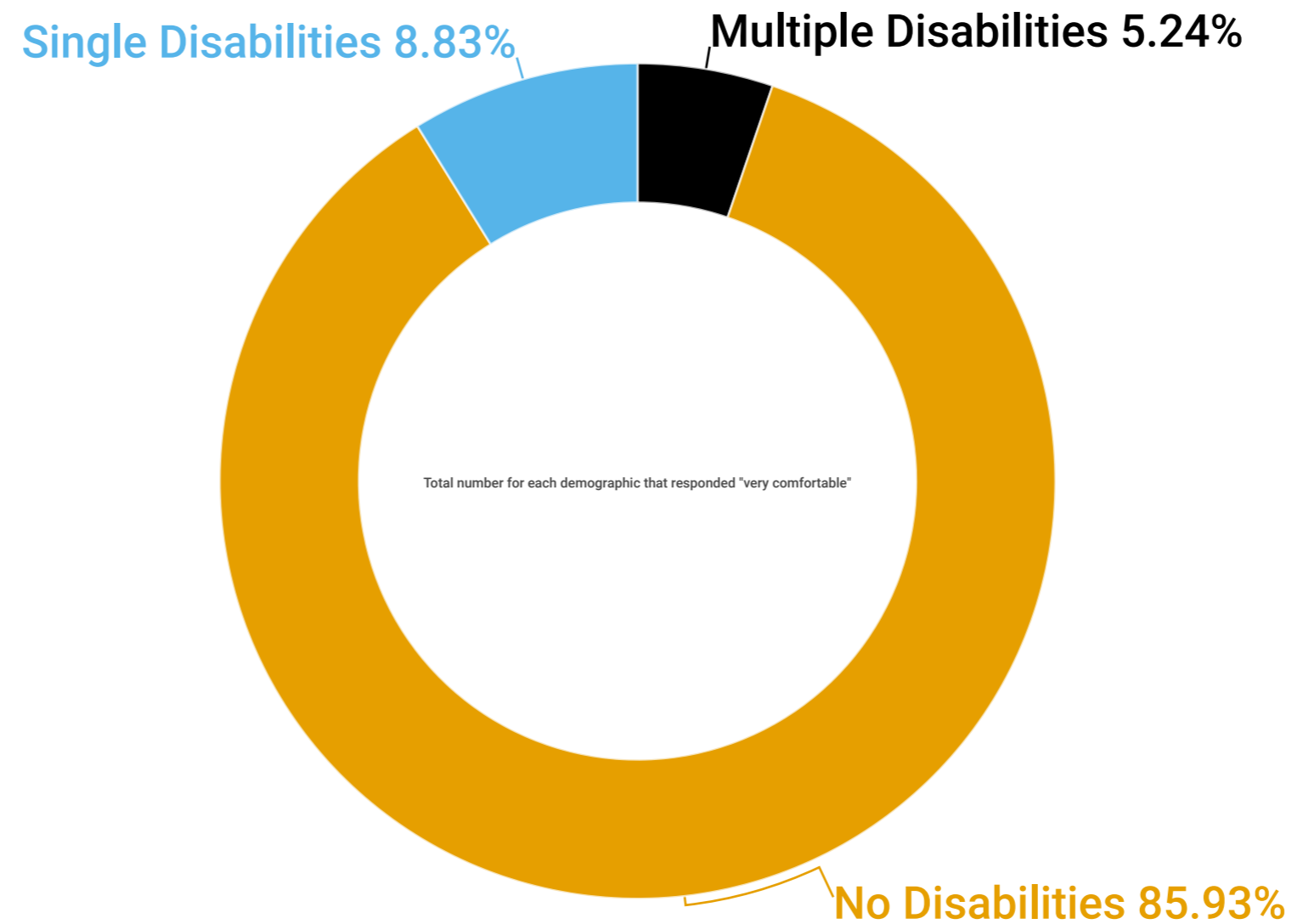
Two limitations that might have influenced the representativeness of the samples are, the respondents as they were "self-selected" to participate, this is a potential issue as it can lead to selection bias. The second, limitation is that the response rate for some groups was less than 30%. this to is a problem as it could lead to inadequate generalization. (Ranking et al., 2019)



### Rhode Island College Climate report, with respect to students with disabilities & classroom climate.

The results revealed the SLD Program assisted students effectively in learning how to improve their individual learning strategies within a warm and supportive setting, supporting student growth in self-advocacy by providing mentoring tools to becoming more independent during college and beyond. (Wilson et al., 2018).

< Total number for each demographic that responded "very comfortable" ∨ >

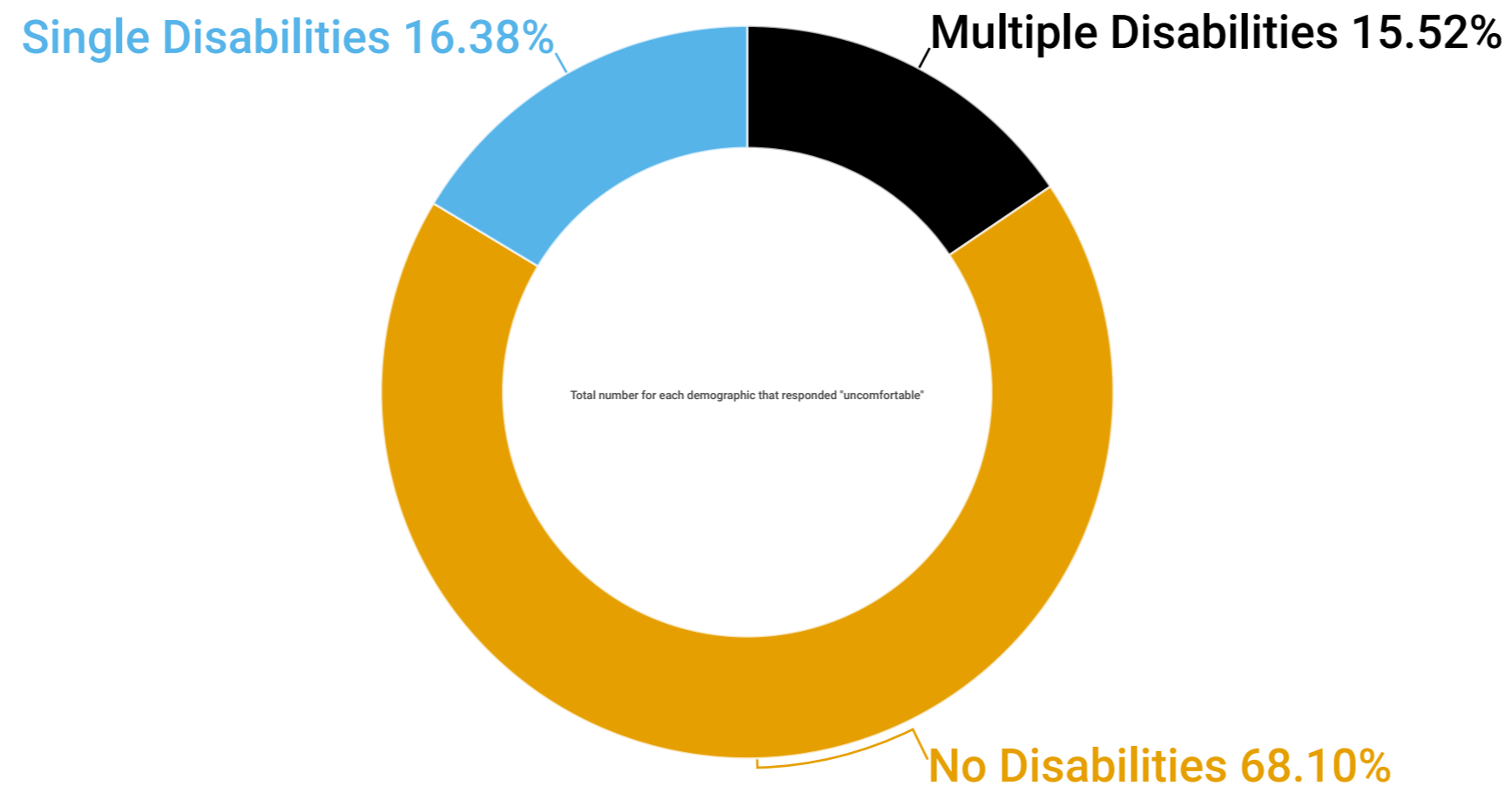




### Rhode Island College Climate report, with respect to students with disabilities & classroom climate.

As students with disabilities break through initial access barriers, they often discover that a complex layer of social barriers still remains beneath the surface. (Trammell et al., 2009)

< Total number for each demographic that responded "uncomfortable" >



There is evidence, for example, that college students with disabilities may be hesitant to disclose to the college or university that they have a disability, in part because of the anticipated negative consequences of that action; that college students with disabilities may worry that accommodations will give them an unfair advantage, or that it will appear to others that they are not competitive. (Trammell et al., 2009).

- How is Success measure amongst students with disabilities?
- What types of disabilities present bigger barriers to students with disabilities?
- How are High Schools preparing students with disabilities to start college?

## Expert opinions and areas for further research

It was reported by College students who self-disclosed to disability support offices confirmed that many students with disabilities transitioned to college with anxiety about the negative stigma effects that could often be traced to earlier school episodes. ( Kranken et al., 2013 ).

Salient factors that contribute to the challenging climate for SWD include lack of faculty knowledge and awareness of the issues that face these students, as well as negative attitudes toward disability and the provision of accommodations. (Trammell et al., 2009)

College students with non-apparent disabilities are considered a vulnerable population because of the impact of intrinsic and extrinsic stressors associated with their impairment.( Kranken et al., 2013)

## Areas of Improvement

- conduct a survey with the potential to address classroom dissatisfaction.
- Work <sup>Type something</sup> alongside High school personal to create a profile of each student and in what way they struggle with their disabilities.

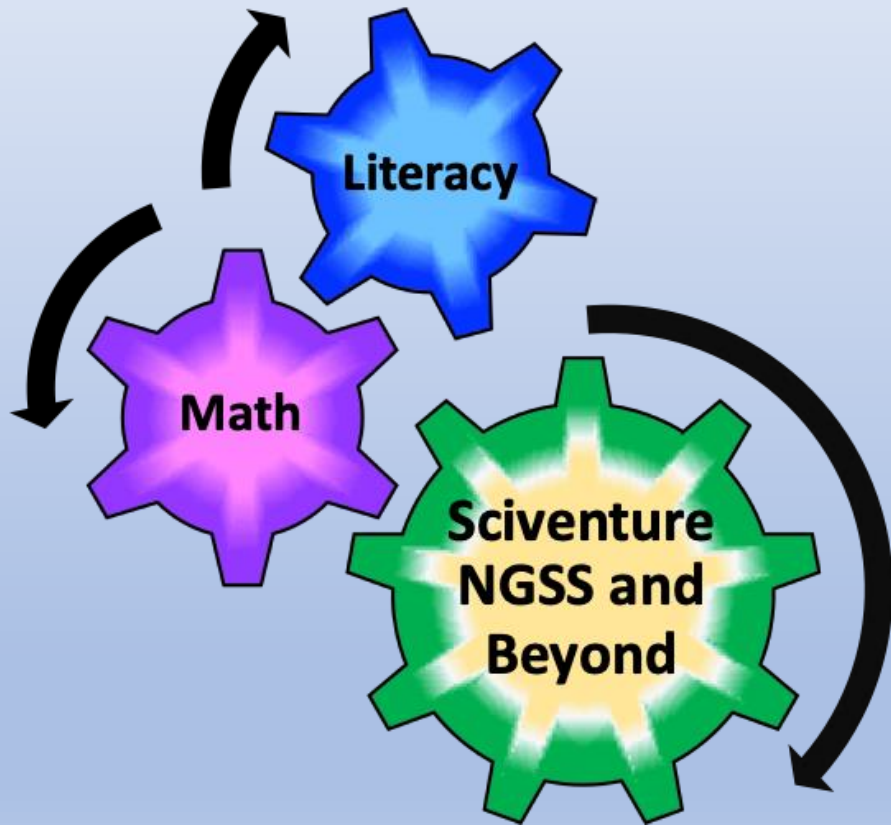
## Proposed solutions and possible areas of improvement

Hiring specialists for students, who could benefit from having access to one.

Working with High School counselors to help students with disability learn of all the accessible aid they are entitled to in their future respective Institutions.

Conducting yearly survey to find out how useful the aid provided to student with disabilities is and what need improvement

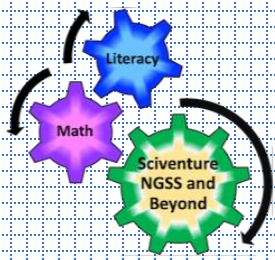
# Eye of a Scientist: The Power of Data Visualization in NGSS Sciventure



Helen Flavin, Ph.D.



[REDACTED]

RIC 2021




Website <http://drhelenflavin.com>


# NSTA STEM Forum – Free Unit Materials

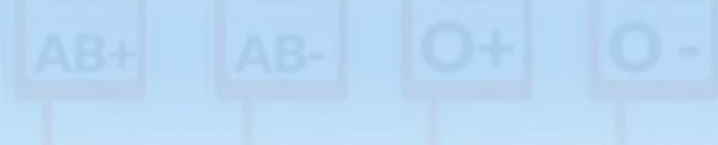
## Eye of a Scientist: Doctor Charles Drew - What is Blood and How is it Used in Transfusion?




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**Sciventre NGSS and Beyond**  
**Unit Materials: Dr. Drew**  
**Helen Flavin, Ph.D.**

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## Unit Design Checklist

<b>Prior Understanding</b>	Blood as red liquid	
<b>Desired Understanding</b>	Be able to explain why a specific unit of blood is acceptable for transfusion to a patient	
<b>Essential Questions</b>	What is blood? What does blood do? How does blood move? What are human blood types? What makes a blood type? What is a transfusion? Can a patient receive all blood types? How does one know what types of blood can be received?	These questions guide Unit design, student discussions throughout the Unit, and growth in depth and complexity of student scientific explanations
<b>Virtual Science Experience</b>	Educational games Nobelprize.org  The Blood Typing Game	<a href="https://educationalgames.nobelprize.org/educational/medicine/bloodtypinggame/">https://educationalgames.nobelprize.org/educational/medicine/bloodtypinggame/</a>
<b>Hands-on Science Ideas</b>	Microscopes and blood smear slides Blood Typing Kit	<a href="http://medsci.indiana.edu/a215/virtualscope/virtual/html5_blood_40x.html">http://medsci.indiana.edu/a215/virtualscope/virtual/html5_blood_40x.html</a>
<b>Scenario for Students to Highlight and Communicate Mastery</b>	Students will cite what they have learned as evidence in a letter they write to the 1942 Red Cross in support of Dr. Charles Drew's position regarding the similarity of blood from Whites, Blacks, and Hispanics	
<b>New Context for Application of Acquired Knowledge</b>	CSIs (Crime Scene Investigators) using blood typing to compare blood found at a crime scene to blood obtained from suspects	

## Nobel Blood Typing Lab - 2020 NSTA STEM Forum Trailer Movie

Nobel Blood Typing Lab - 2020 NSTA STEM Forum Trailer

Exploration 5: Blood Typing: Q 2 – Which Antigens cannot be on incoming RBCs



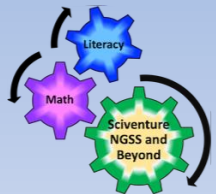
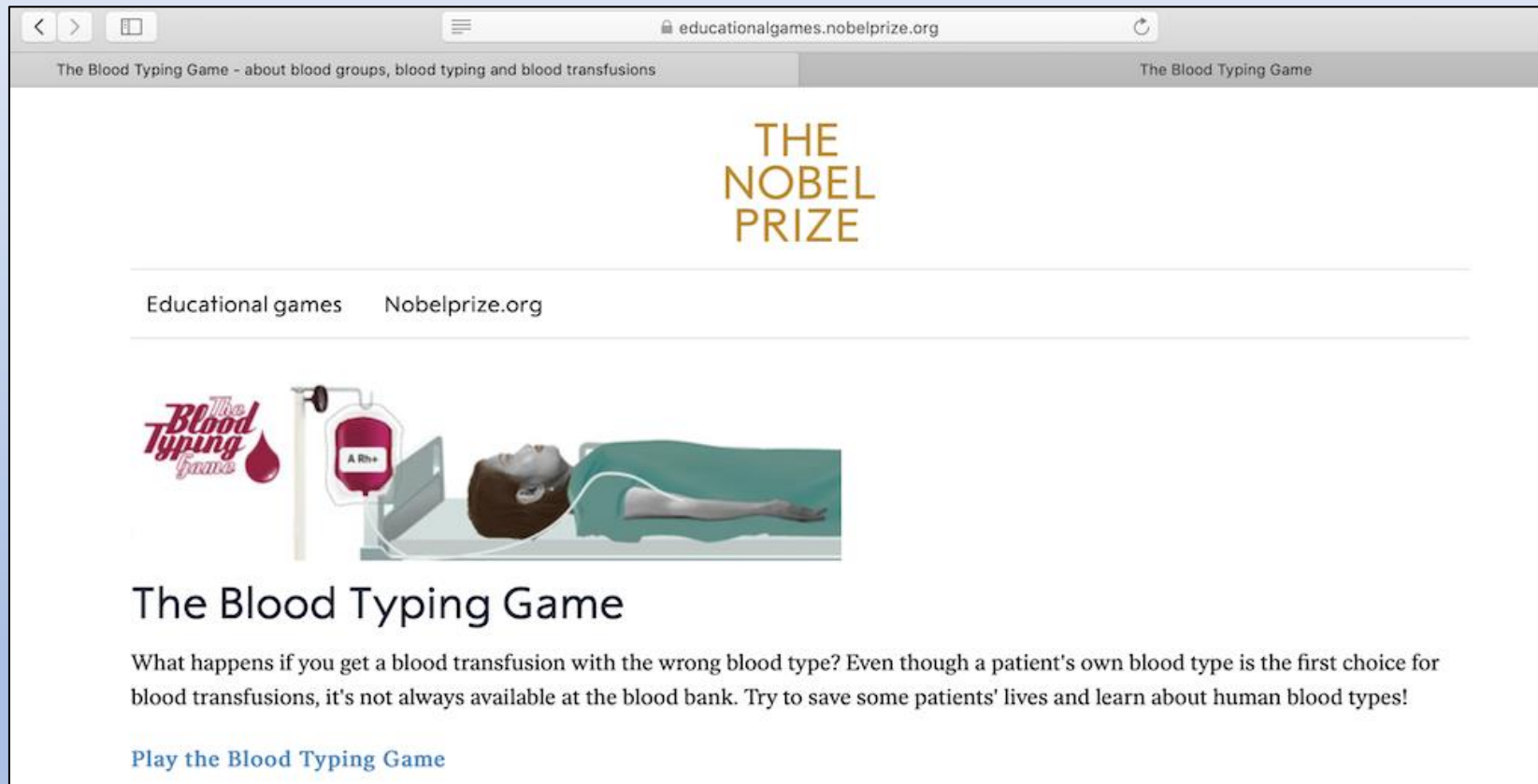
### Student-Scientists:

- Are the physician calling for the correct blood for patient transfusions.
- Use pie charts to analyze RBC data from Black, Hispanic, and White patients.
- Write a persuasive essay to the (1942) American Red Cross in support of Dr. Charles Drew's assertion that the science does not support the need for racial blood segregation.

Hands-on complimentary activities include blood smear under microscope as well as blood typing.

NGSS Unit content can be used at MS through HS levels. It is easily used as a framework in a larger project encompassing additional MS-LS or HS-LS NGSS standards.

# Within the Virtual lab Students are Doctors saving Lives with Transfusions



<https://educationalgames.nobelprize.org/educational/medicine/bloodtypinggame/>

# Literacy Connection: Deeper Dive into What is Blood?

## Tutorial 1

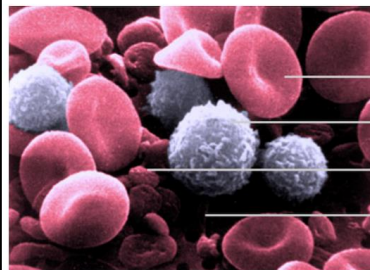
### What is a blood type?

Before Nobel Prize awarded Karl Landsteiner discovered the ABO human blood groups in 1901, it was thought that all blood was the same. This misunderstanding led to fatal blood transfusions. Later, in 1940, Landsteiner was part of discovering another blood group, the Rh blood group system. There are many blood group systems known today, but the ABO and the Rh blood groups are the most important ones used for blood transfusions. The designation Rh is derived from the Rhesus monkey in which the existence of the Rh blood group was discovered.

### What is blood made up of?

An adult human has about 4–6 liters of blood circulating in the body. Among other things, blood transports oxygen to various parts of the body.

Blood consists of several types of cells floating around in a fluid called plasma.



Red blood cells  
White blood cells  
Platelet  
Plasma

Image source: National Cancer Institute, USA. Photo: Bruce Wetzel and Harry Schaefer  
This is a scanning electron microscope image of human blood.

**The red blood cells** contain hemoglobin, a protein that binds oxygen. Red blood cells transport oxygen to, and remove carbon dioxide from, the body tissues.

**The white blood cells** fight infection. One type of infection-fighting white blood cells fight disease by producing antibodies and thus destroying foreign materia.

**The platelets** help the blood to clot, if you get a wound for example.

**The plasma** contains salts and various kinds of proteins.

### How do the blood types differ?

Our blood types are determined by heredity. People belong to either of eight different blood types:

A Rh+, A Rh-, B Rh+, B Rh-, AB RH+, AB Rh-, O Rh+, or O Rh- .

The eight blood types have different combinations of certain molecules, *antigens*, on the surface of the red blood cells. The A and B antigens are sugars and the Rh antigens are proteins. The antigens expressed in the red blood cells determine an individual's blood type.

Also the combination of some other molecules floating around in the blood plasma differs between the eight blood types, the so called *antibodies*.

You can have **A or/and B or/and Rh antigens** or none of them.

You can have **A or/and B or/and Rh antibodies** or none of them.

### All eight blood types

Blood type A Rh-

**Antigens (on the surface of the red blood cells):**

A indicates there are A antigens.

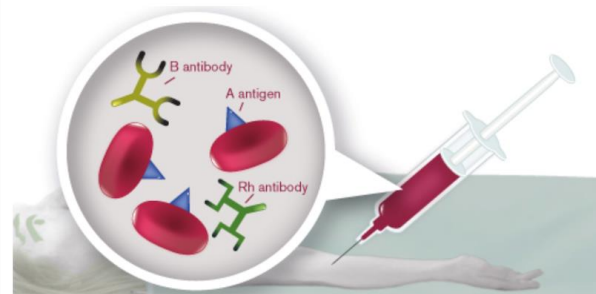
(Rh- indicates there are no Rh antigens)

**Antibodies (in the blood plasma):**

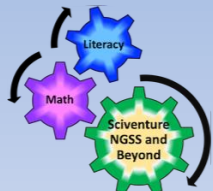
B antibodies.

Rh antibodies.

(If there are A and B antigens but no B nor Rh antigens, the antibodies in the blood plasma are B and Rh antibodies.)



The blood type notation A Rh- indicates which antigens and antibodies are present in the blood.



# Highlight and Communicate Mastery

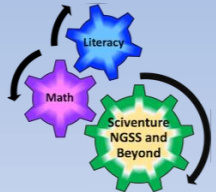
Dear Dr. Drew,

1942

Your words yesterday about human blood were persuasive. Yet, you did not present any evidence. The Board of Directors has decided it best to go with their initial decision. Each Unit of Blood will be labeled with the Blood Type as well as race of the individual.

If you or a member of your team would write to share the scientific evidence that human blood is similar among all races, then perhaps the question could be revisited.

Head Administrator  
American Red Cross

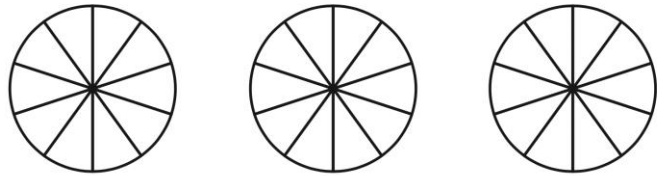




# RBCs: Age, Race, and Anemia

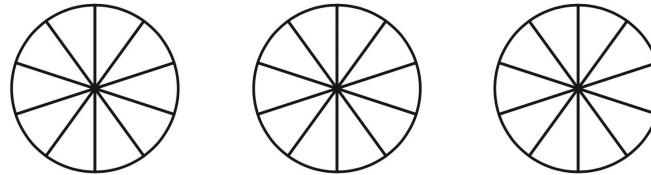
Group 3

Hispanic Male		White Male		Black Male	
RBC	53%	RBC	52%	RBC	54%
Plasma	46%	Plasma	47%	Plasma	45%
WBC	1%	WBC	1%	WBC	1%



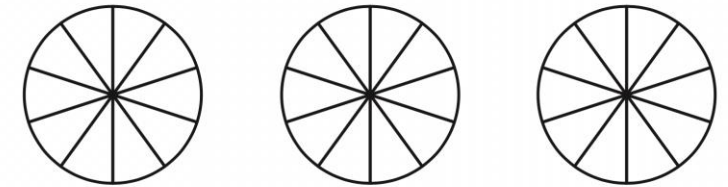
Group 2

Adult Male		Adult Female		Female Anemia Patient	
RBC	50%	RBC	40%	RBC	25%
Plasma	49%	Plasma	59%	Plasma	74%
WBC	1%	WBC	1%	WBC	1%



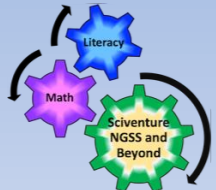
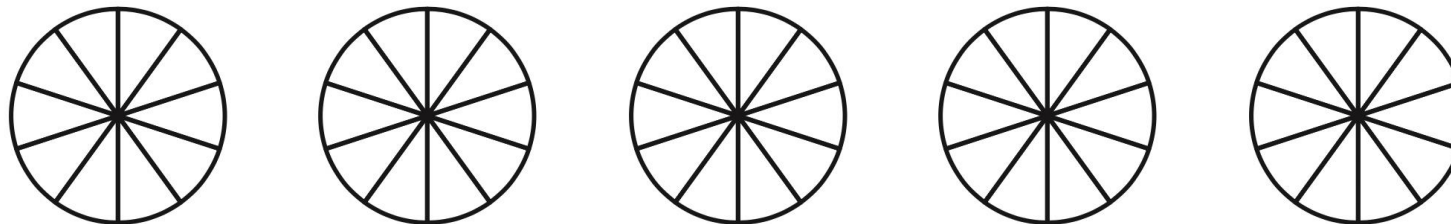
Group 4

Hispanic Female		White Female		Black Female	
RBC	45%	RBC	43%	RBC	44%
Plasma	54%	Plasma	56%	Plasma	55%
WBC	1%	WBC	1%	WBC	1%



Group 1

Newborn (Male)		3 Months Old		1 Year Old		10 Years Old		Adult	
RBC	65%	RBC	35%	RBC	40%	RBC	40%	RBC	55%
Plasma	34%	Plasma	64%	Plasma	59%	Plasma	59%	Plasma	44%
WBC	1%	WBC	1%	WBC	1%	WBC	1%	WBC	1%

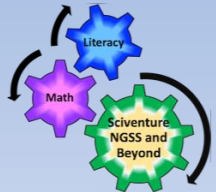
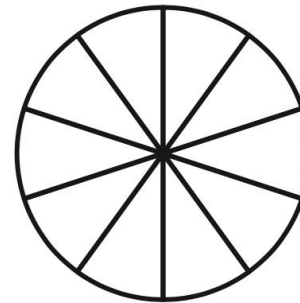
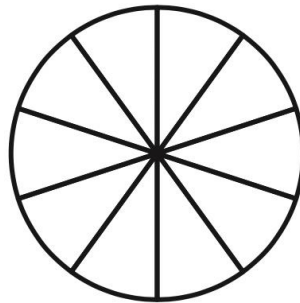
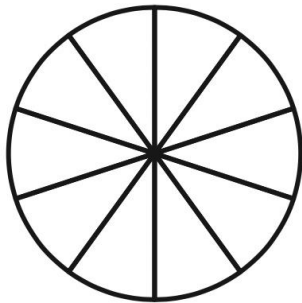


# Blood of Different Races

Person with Anemia seems to have very few RBCs

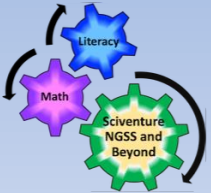
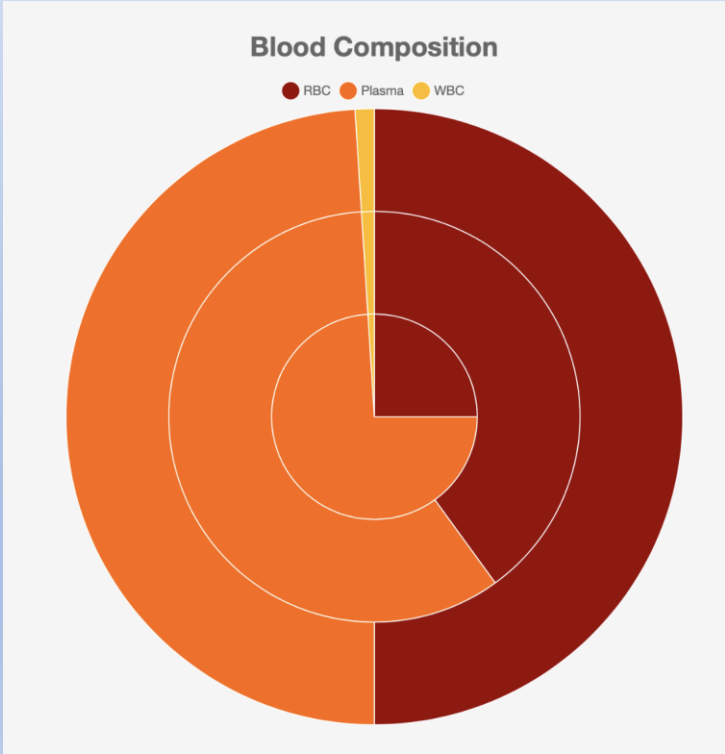
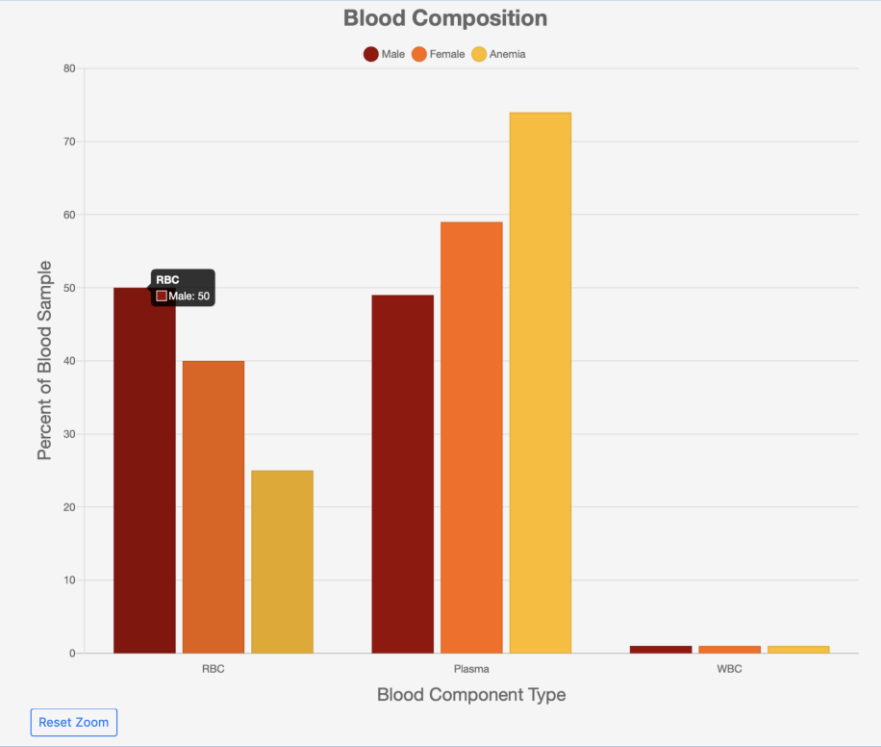
## Group 2

Adult Male			Adult Female			Female Anemia Patient		
RBC	50%		RBC	40%		RBC	25%	
Plasma	49%		Plasma	59%		Plasma	74%	
WBC	1%		WBC	1%		WBC	1%	



# Blood of Different Races

	A	Male	Female	Anemia
1	RBC	50	40	25
2	Plasma	49	59	74
3	WBC	1	1	1



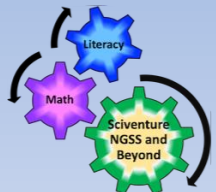
# Exploration 2: Blood of Different Races

Discover – The percent of RBCs changes over a person's lifetime

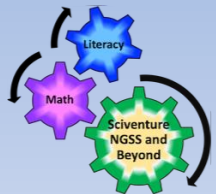
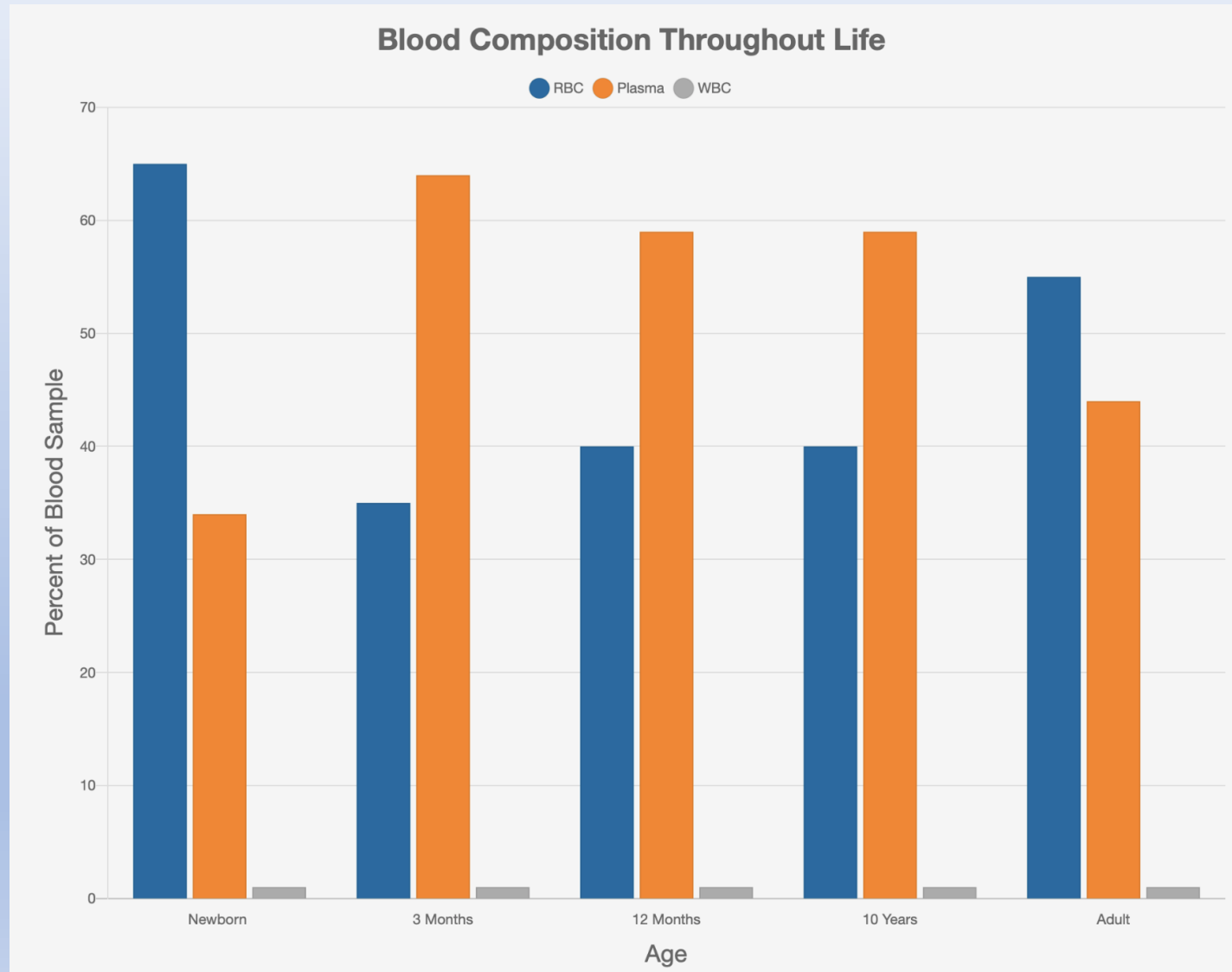
## Group 1

Newborn (Male)		3 Months Old		1 Year Old		10 Years Old		Adult	
RBC	65%	RBC	35%	RBC	40%	RBC	40%	RBC	55%
Plasma	34%	Plasma	64%	Plasma	59%	Plasma	59%	Plasma	44%
WBC	1%	WBC	1%	WBC	1%	WBC	1%	WBC	1%

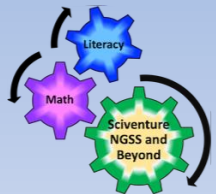
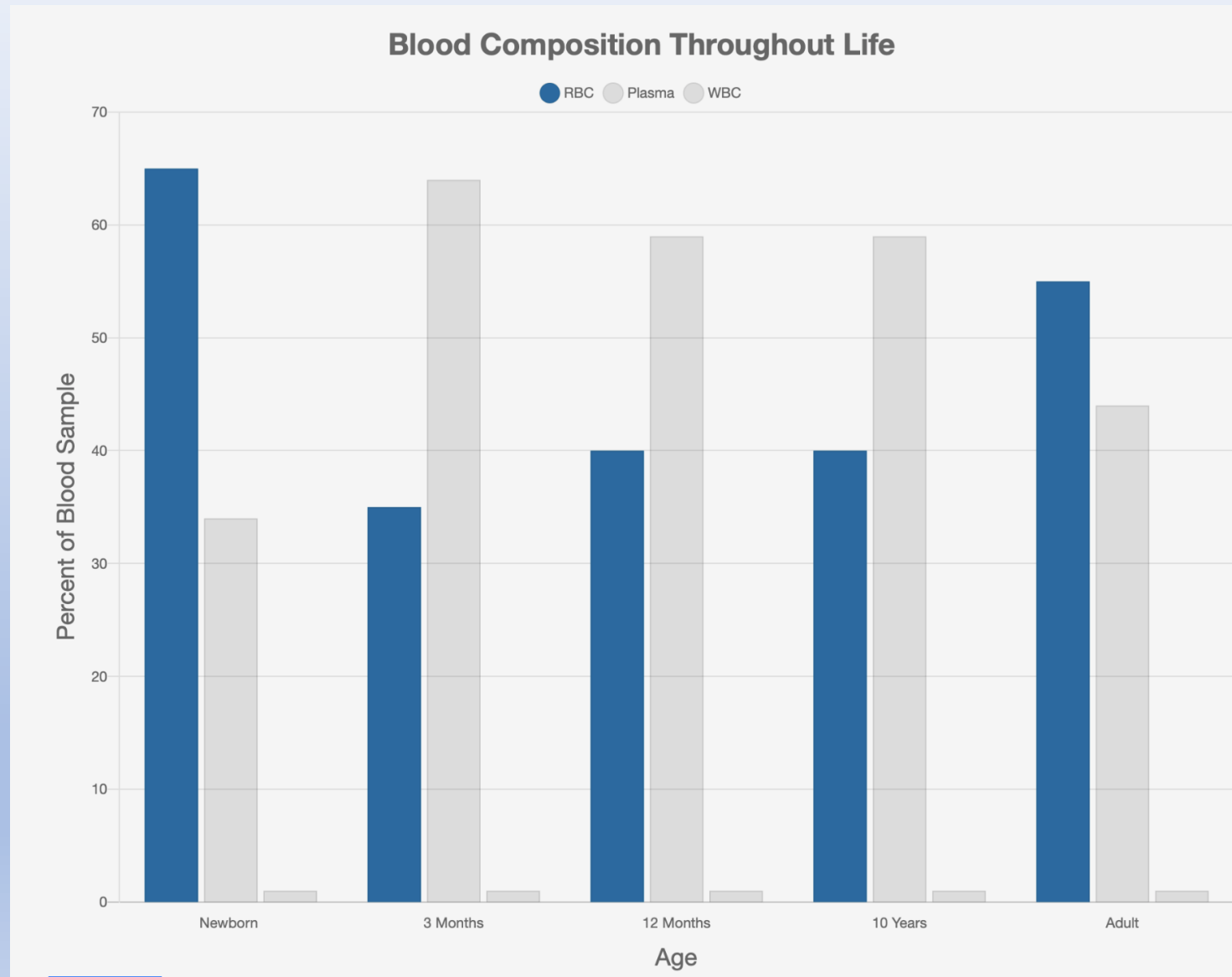
	A	RBC	Plasma	WBC
1	Newborn	65	34	1
2	3 Months	35	64	1
3	12 Months	40	59	1
4	10 Years	40	59	1
5	Adult	55	44	1



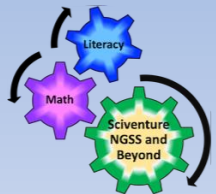
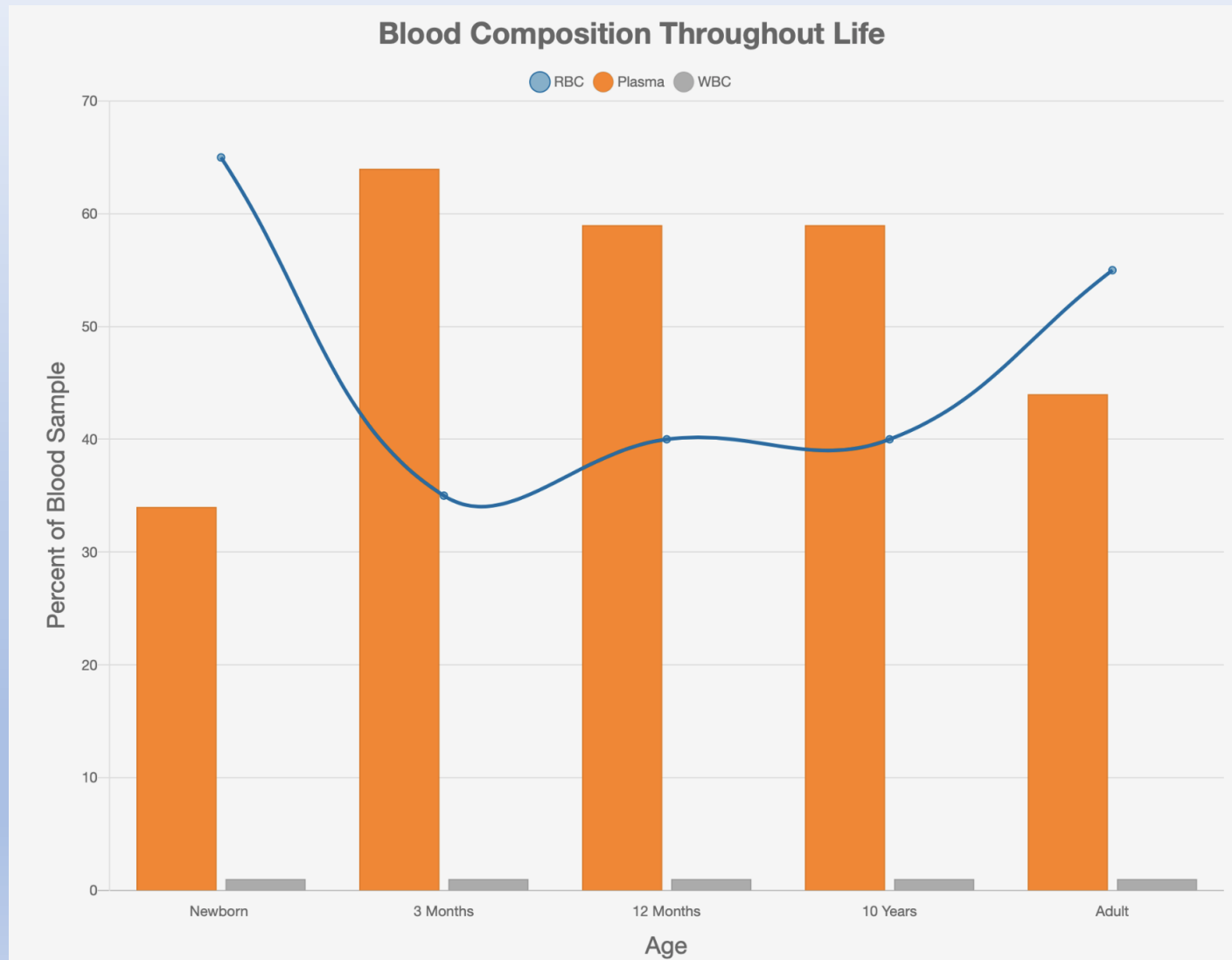
# Exploration 2: Blood of Different Races



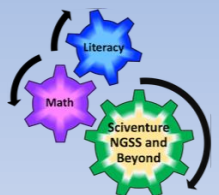
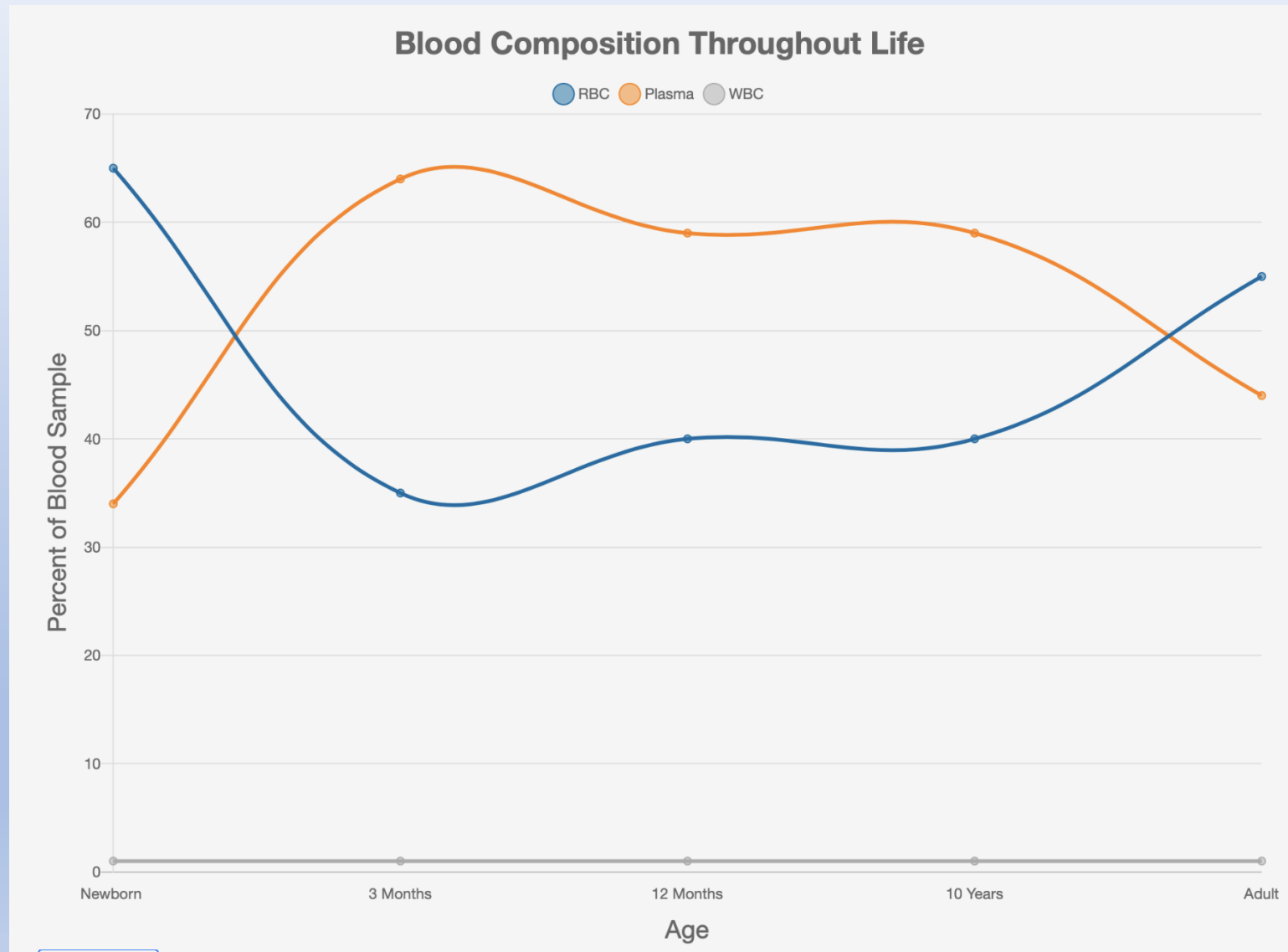
# Exploration 2: Blood of Different Races



# Exploration 2: Blood of Different Races

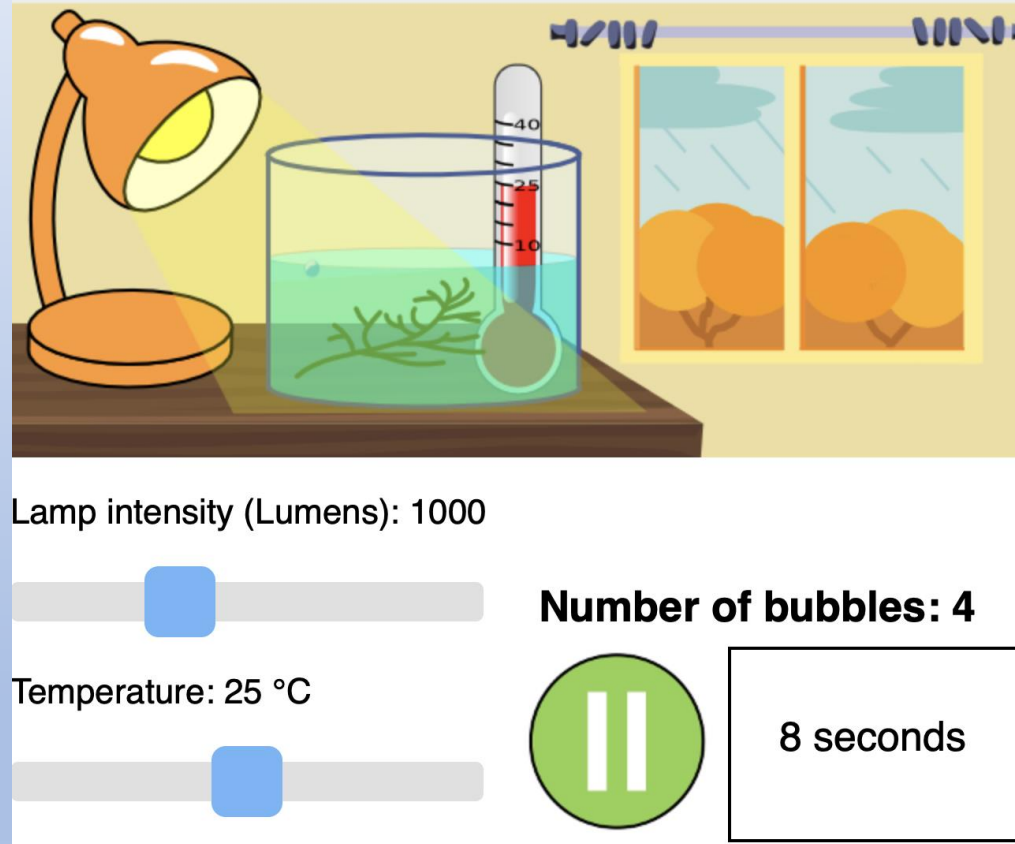


# Exploration 2: Blood of Different Races



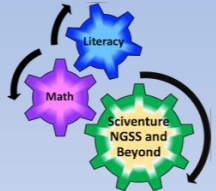


# Photosynthesis (Middle School)



Virtual or Hands-on  
Photosynthesis Lab

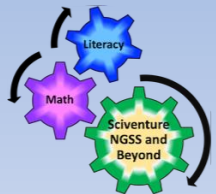
<https://leosiiman.neocities.org/lab-rate-of-photosynthesis/photolab-individual.html>



# Assessment: Science Experiment Analysis

You are a scientist. You were given an “unknown” chemical and asked to determine its effects on photosynthesis. The person who developed the chemical hoped that farmers could use it so that the plants would be able to grow larger and thus and yield more product.

**Experiment Description:** You used 10 sugar cane plants (each 1 cm tall). Weeds were also 1 cm tall. All plants had received a 12-hour light then 12-hour dark cycle. Each plant was watered once a day with either pure water or the amount of chemical. For the Photosynthesis experiment, you used a magnifying glass to measure the number of bubbles forming on each leaf. The data are in the data table below.



# Students Add Data

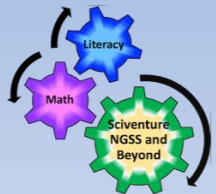
For best results, delete all empty columns/rows and rename the headers (A, B, C) with the dataset's names.

	Chemical	Plant	C
1	0	12	10
2	25	14	9
3	50	16	5
4	100	18	2
5	500	19	1

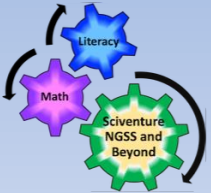
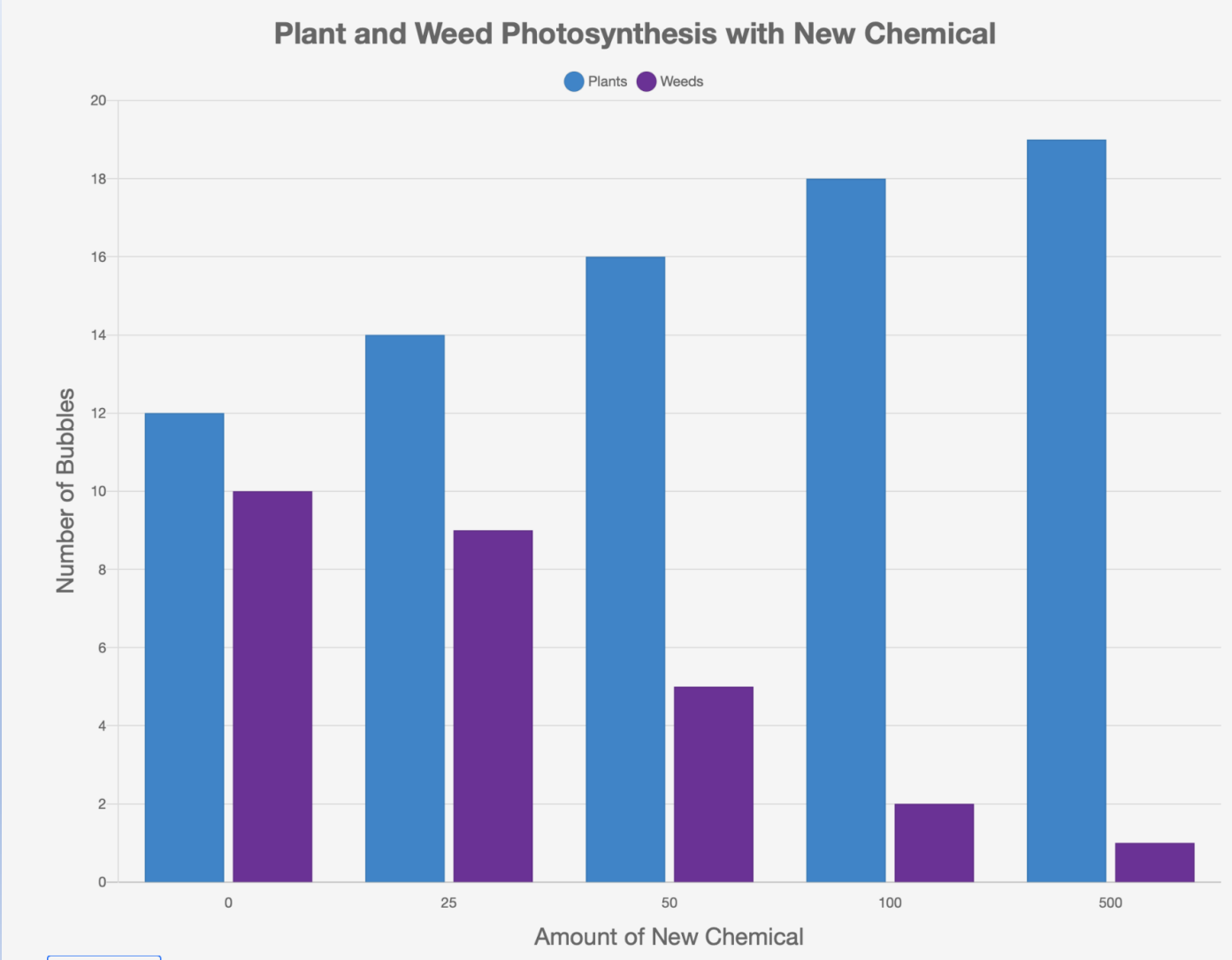
- Insert a new column before
- Insert a new column after
- Delete selected columns
- Rename this column
- Order ascending
- Order descending
- Copy...      Ctrl + C
- Paste...      Ctrl + V
- Save as...      Ctrl + S
- About

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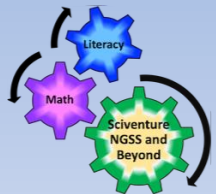


# Data Visualization



# Formative or Summative Assessment Questions

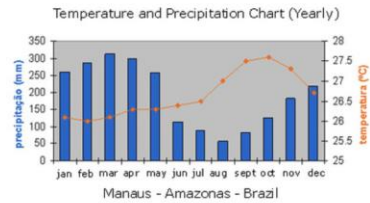
1. **(5 pts)** Why did the experiment have some plants that just received water (none of our new chemical)? Please explain why this was important.
2. **(5 pts)** Identify the responding (dependent) variable for the experiment
3. **(6 pts)** Identify three control variables for the experiment.
4. **(4 pts)** Identify the manipulated variable in the experiment. [Hint: it is NOT the type of plant]
5. **(4 pts)** What effect (if any) does the new chemical seem to have on the sugar cane plants?
6. **(4 pts)** What effect (if any) does the new chemical appear to have on weeds?
7. **(10 pts)** Does the chemical produce a large response? Is there a market for this product? Should we continue with this chemical? What is your recommendation?



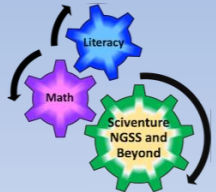
# Biomes

## Climate

The rain fall averages about 125 – 660 cms yearly. Because of this, it is very humid. The average temperature generally falls between 20°C and 34°C. Tropical Rainforest Biomes cover only 6% of the earth's surface. They are mainly located near the equator and their placement on the earth is responsible for its humidity. There is a lot of direct sunlight hitting the land and the sea, more so than any other biome. The sun heats up the land and sea, making the water evaporate into the air. After some time, the water evaporated cools down, therefore making the water fall as rain. This climate is perfect for plants and animals.

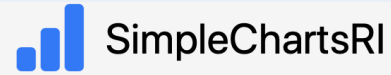
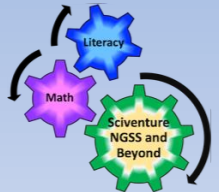


	A	Precipitation (cm)	Temperature (F)
1	January	28.8	80.6
2	February	28.9	80.6
3	March	30.8	80.6
4	April	31.0	80.6
5	May	24.5	80.6
6	June	12.2	80.6
7	July	9.2	80.6
8	August	6.8	82.4
9	September	8.8	82.4
10	October	12.2	82.4



# Biomes

## Change Dataset's Chart Type



### 3) Customize & Interact

Click & drag on the chart to pan. Scroll to zoom. Hover over chart elements to see their respective values. Hover over datasets in the legend to bring them into focus, or click them to hide/show them.

Chart Title

 ?

X-Axis Label

 ?

Y-Axis Label

 ?

Color Style

Pick a color style ?

Hide Legend  ?

Horizontal  ? Stacked  ?

Dataset

Temperature (F) ?

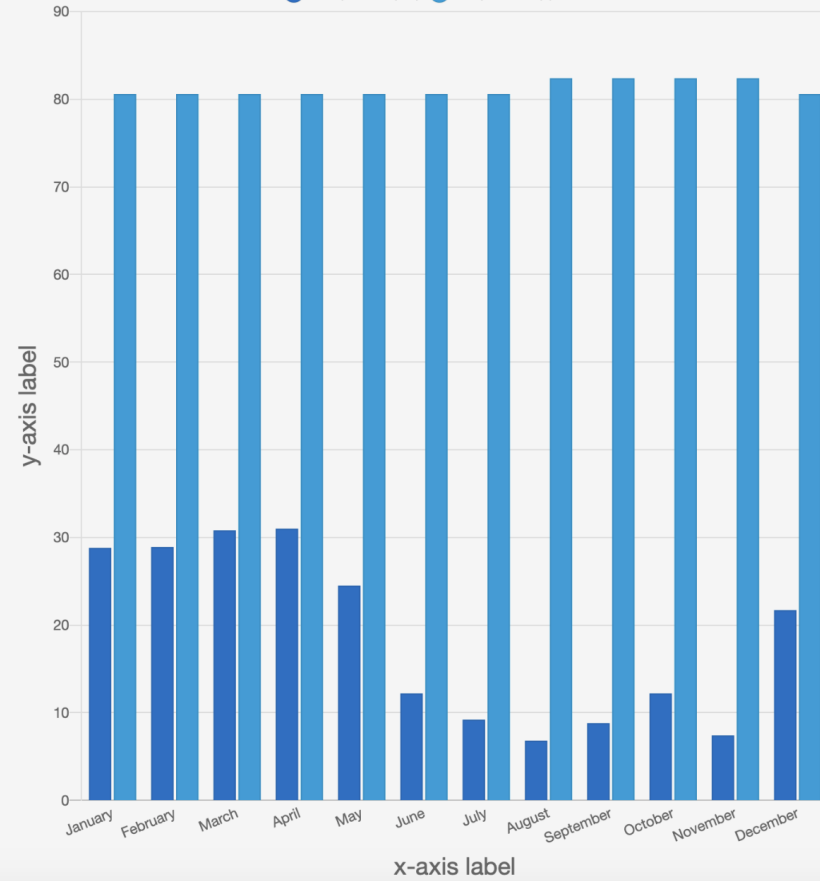
Dataset's Chart Type

- ✓ Bar ?
- Line ?
- Scatter ?
- Area ?

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chart title

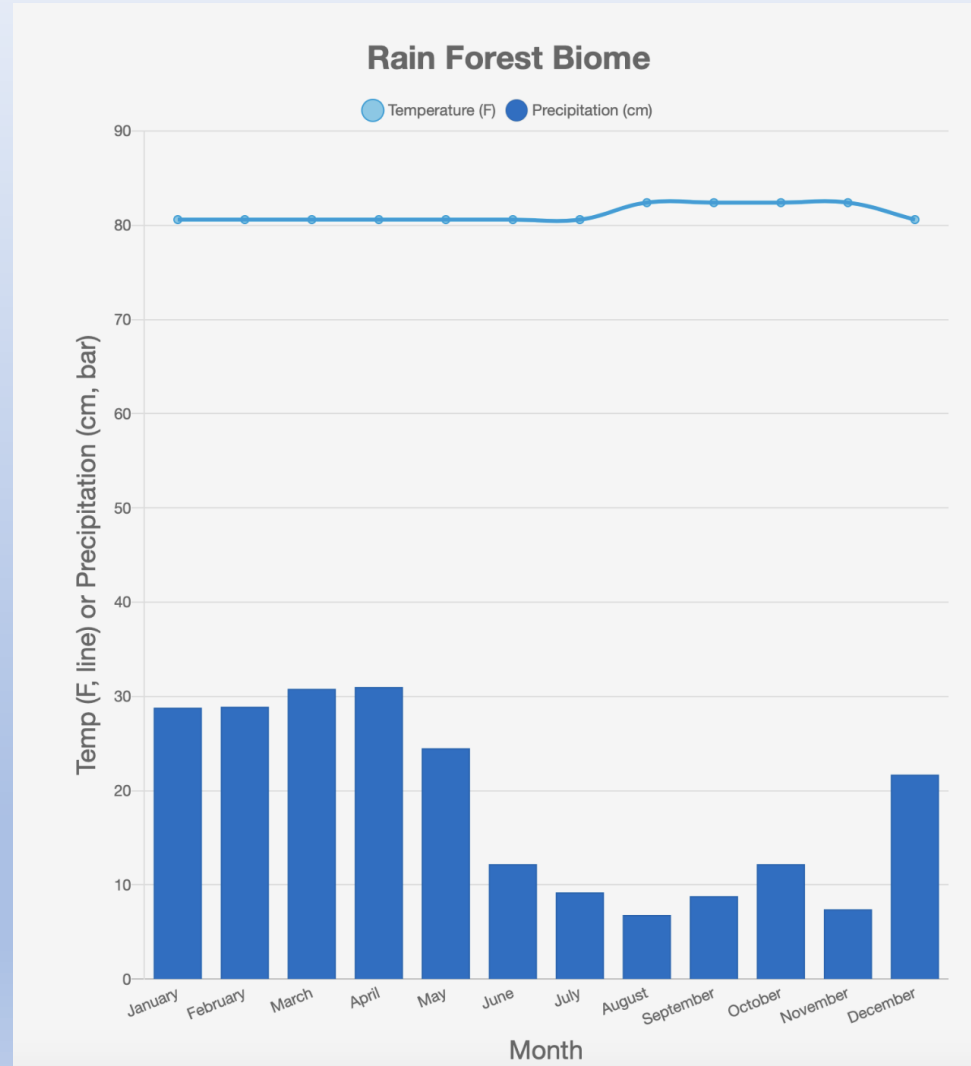
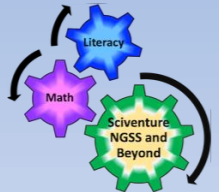
Precipitation (cm) Temperature (F)



# Biomes

Jigsaw Activity with each Group assigned one Biome

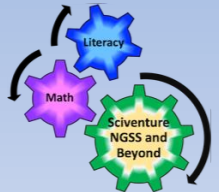
- ❖ Plants
- ❖ Animals
- ❖ Food Chain or Web
- ❖ Abiotic
- ❖ Other



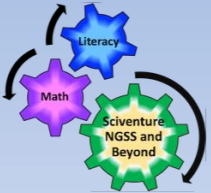
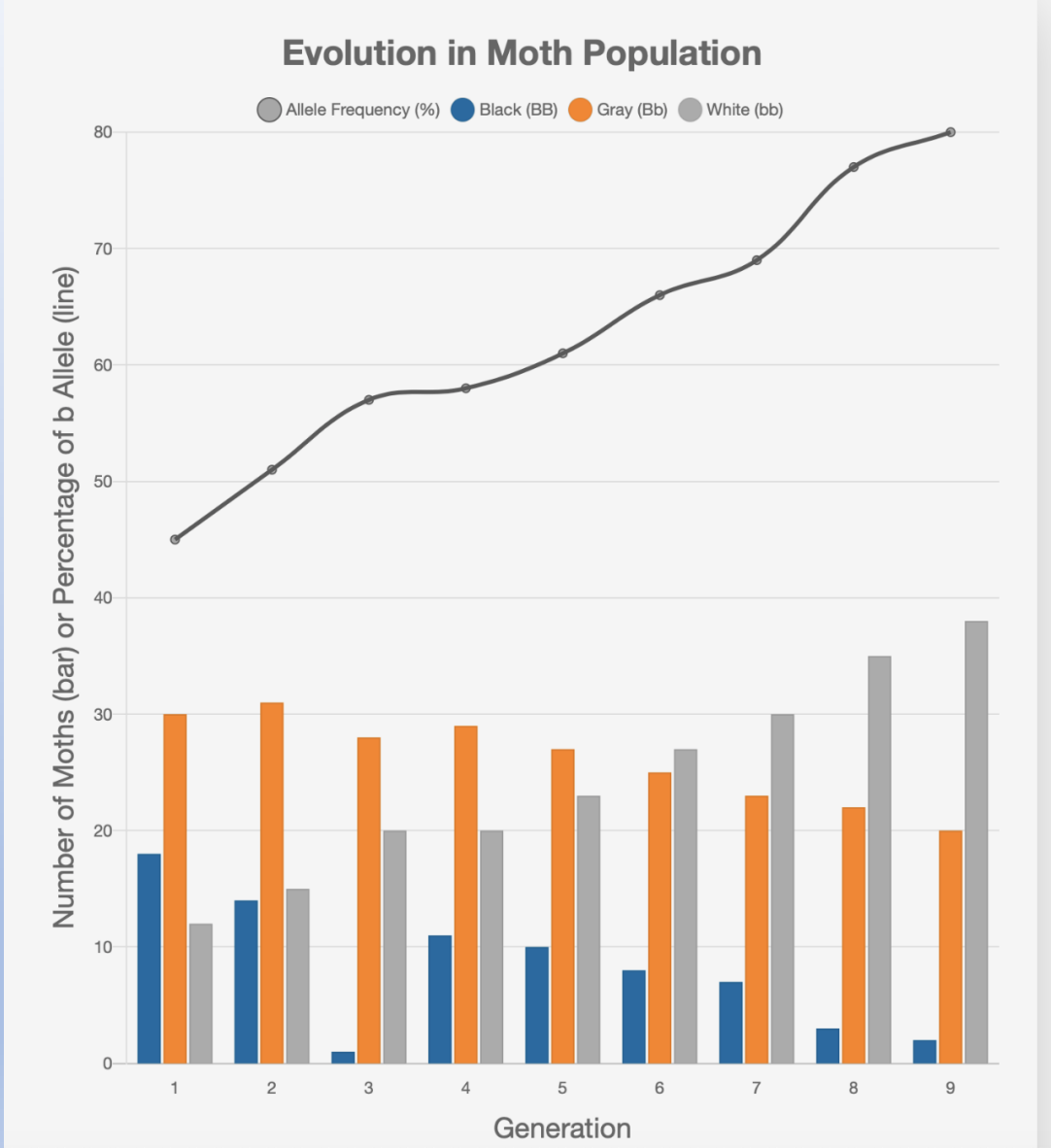


# Evolution

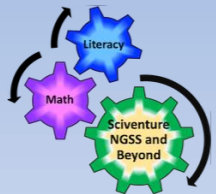
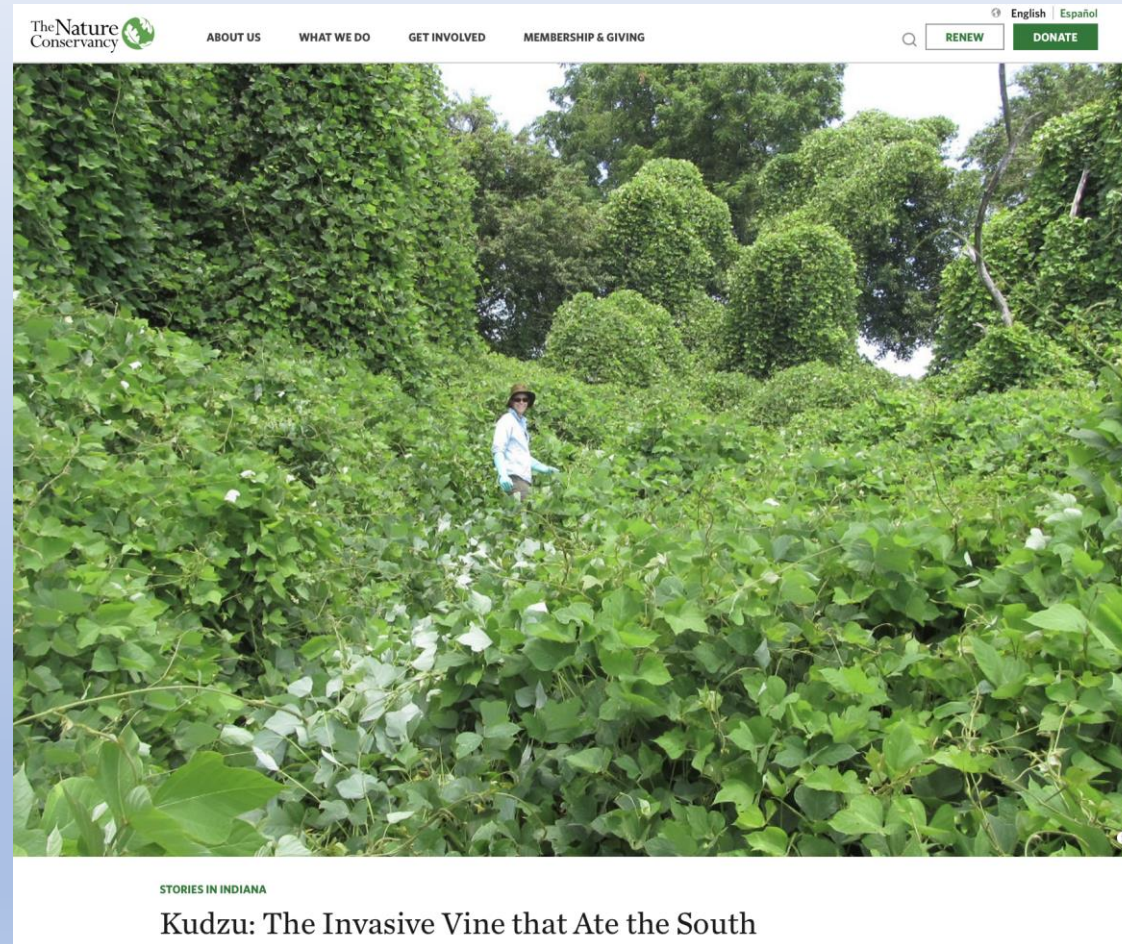
	Generation	Black (BB)	Gray (Bb)	White (bb)	Allele Frequency (%)
1	1	18	30	12	45
2	2	14	31	15	51
3	3	1	28	20	57
4	4	11	29	20	58
5	5	10	27	23	61
6	6	8	25	27	66
7	7	7	23	30	69
8	8	3	22	35	77
9	9	2	20	38	80



# Evolution

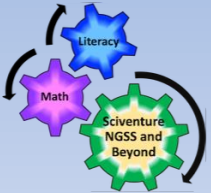
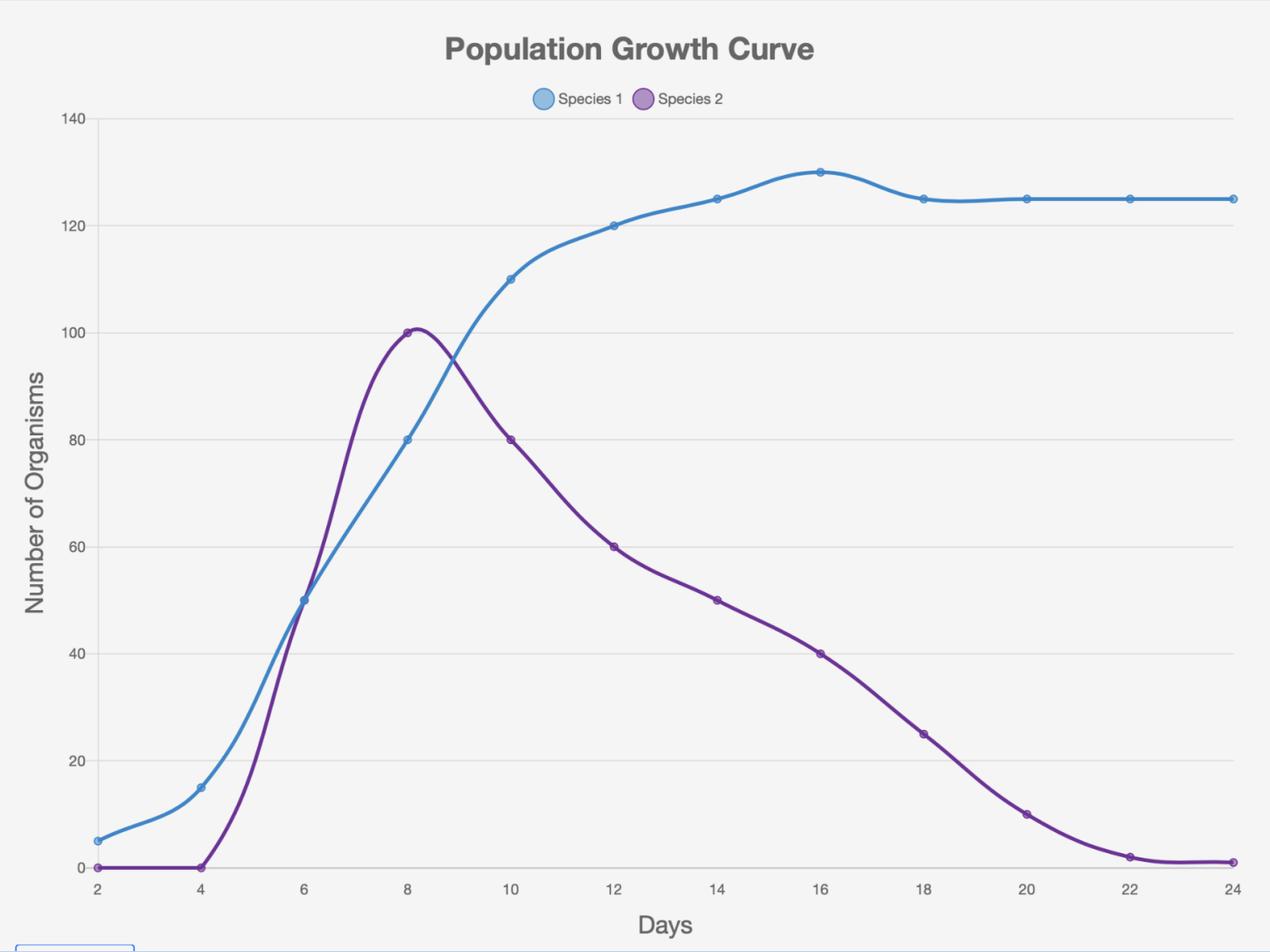


# Ecology - Kudtz Invasive Species...



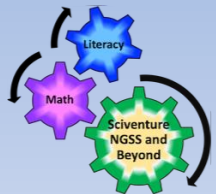
<https://www.nature.org/en-us/about-us/where-we-work/united-states/indiana/stories-in-indiana/kudzu-invasive-species/>

# Population Biology: Competition, Carrying Capacity

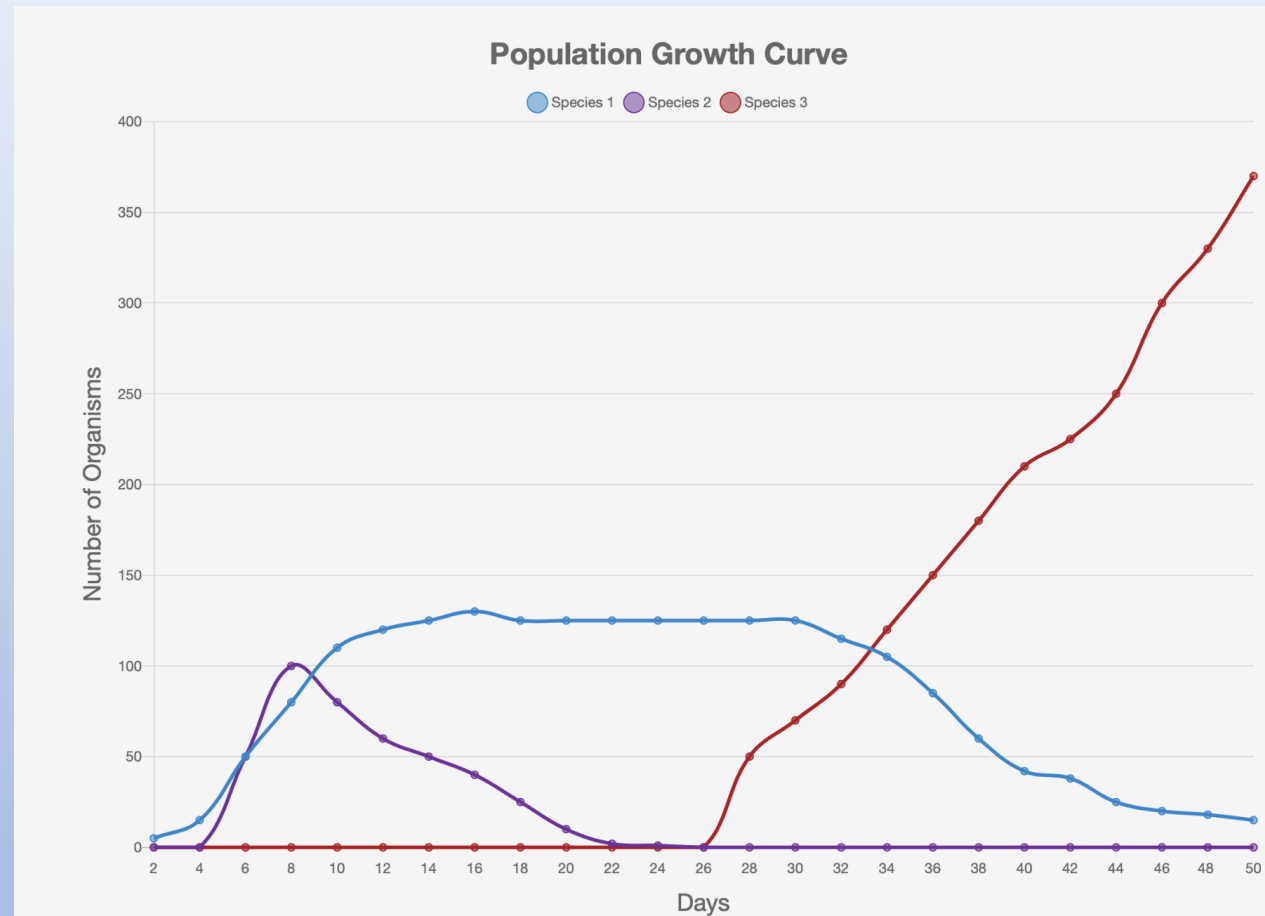


# Population Data for all 3 Species

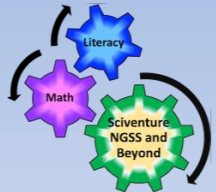
	Days	Species 1	Species 2	Species 3
11	22	125	2	0
12	24	125	1	0
13	26	125	0	0
14	28	125	0	50
15	30	125	0	70
16	32	115	0	90
17	34	105	0	120
18	36	85	0	150
19	38	60	0	180
20	40	42	0	210



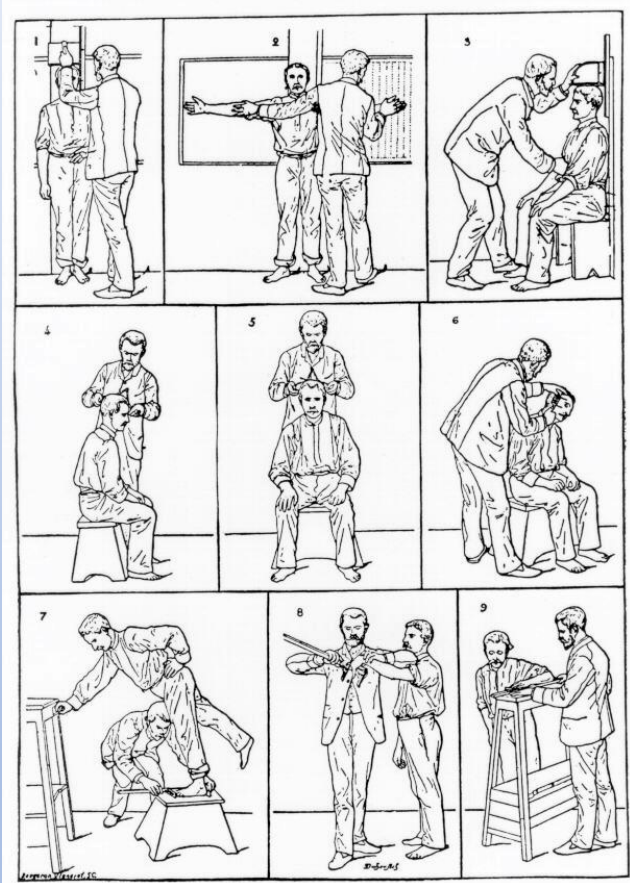
# Species 3 is an invasive Species with no Natural Predator



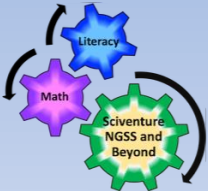
<https://www.nationalgeographic.org/encyclopedia/invasive-species/> Interesting article on mankind's attempts to reign in invasive species



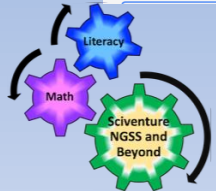
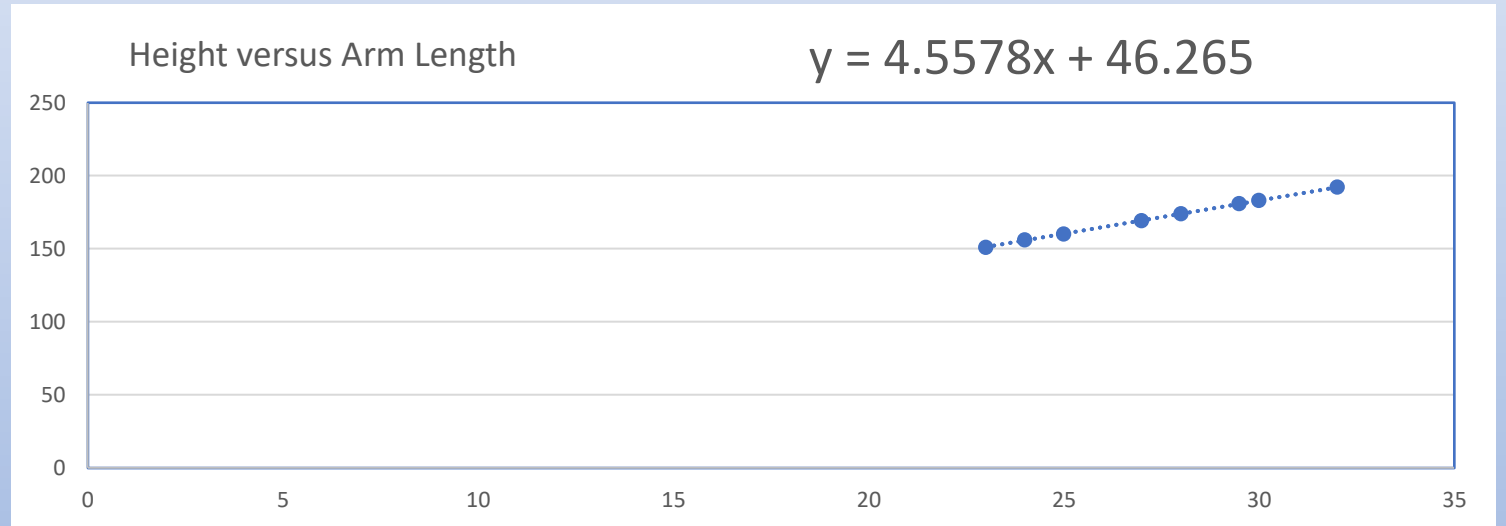
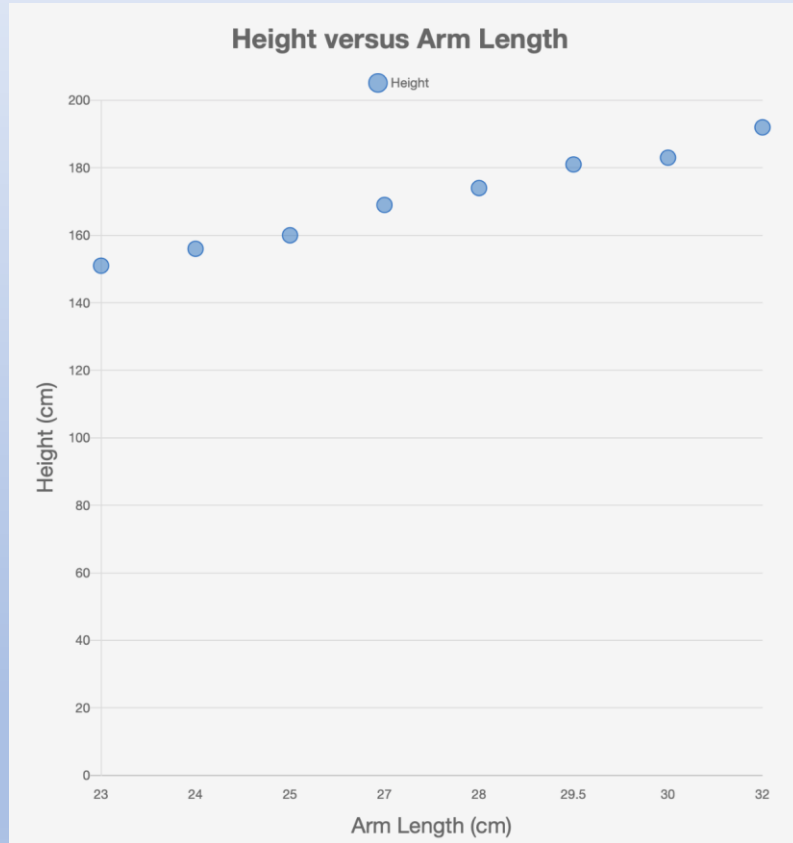
# Bertillon



	Arm Length	Height
1	23	151
2	24	156
3	25	160
4	27	169
5	28	174
6	29.5	181
7	30	183
8	32	192

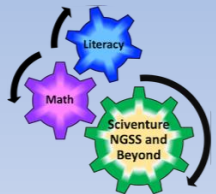


# Bertillon: Height of Individual from Skeletal Remains





# Do not use Trendline!



# iRNA - NGSS HS LS1 (DNA to Protein)

## Proposal

The protein I would like to suggest is an enzyme involved in the synthesis of Vitamin C. Protozoa, bacteria, fungi, plants, and animals all have this gene.

Attention Grabber: Pirates, citrus, and no scurvy! Why?

Big Picture: DNA to mRNA to Protein

Jigsaw Activity: Each group of Student-Scientists has a segment of the DNA (from one species) for this enzyme. The group determines the amino acid sequence from their assigned DNA. Group debrief determines some species make the functional enzyme, but others do not (e.g. some bats make the enzyme and Vitamin C, but others do not). Allows connections to Vitamin C in diet and/or evolution.

### Vitamin C Biosynthesis iRNA Virtual Lab:

A new species has been discovered that synthesizes an excessive amount of Vitamin C. It has been suggested that a treatment to reduce mRNA would be effective. Student-Scientists are to determine the best medical intervention:

- HHMI Interactive on iRNA and Nature animation on iRNA (5 min movie)
- Visualize data with SimpleChartsRI. Determine most effective treatment.
- Sketch and/or explain how iRNA#1 drastically reduces Vitamin C levels.
- Decide which iRNA to make and try next. Predict the anticipated Vitamin C level.

As part of a larger unit (or even as a look ahead to next year) where might design continue? The current jigsaw structure mirrored the samples provided. The assignments were parallel, involving similar analysis and conclusions. One idea would be to build upon the jigsaw with a group becoming the expert at one of the following: analysis of a new way to increase Vitamin C absorption; designing a way to "fix" the non-functional Vitamin C gene in an animal model; the detailed structure/function story of the enzyme; use this enzyme's DNA data to refine a cladogram; and provide data for students to visualize enzyme kinetics. At this jigsaw level, Student-Scientists prepare then share their one area of expertise. They learn from the presentations of their colleagues. This presentation system mirrors a scientific conference.

*Helen Flavin, Ph.D.*

## Biosynthesis of Vitamin C and iRNA Virtual Lab

### Vit C Data Table

Use NSF SimpleChartsRI to submit data for visualization



### Visualize Vit C Data

Discuss the different effects of the three iRNAs. Which is best? Might there be an even more effective one?

### Expected iRNA#4

Predict what the data would look like for an optimized iRNA. Add data to the table then figure

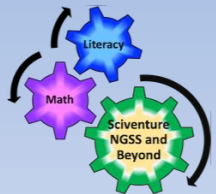


### Structure Data for iRNA #1 - 4

```
iRNA1  CCCCCCCCCC  
iRNA2  XXXXXXXXXXXX  
iRNA3  XXXXXXXXXXXX  
iRNA4  CCCCCCCCCC
```

### iRNA Structures

This is to illustrate iRNA structures. Bottom is "sticky" part. Red C indicates complimentary to mRNA. There is more than one possible design. Explain why design is better at removing mRNA.

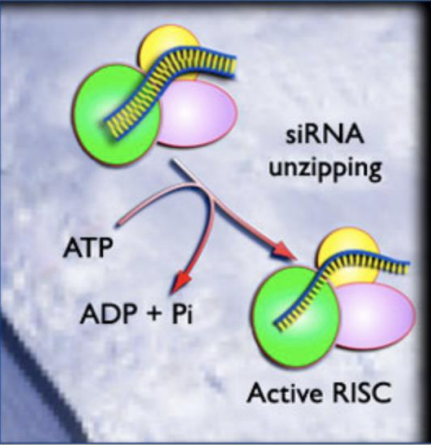


# HHMI Interactive how iRNA Works...

**RNA Interference**  
Howard Hughes Medical Institute

HOW RNAi WORKS (CONTINUED)

- RISC becomes activated when the double-stranded siRNA it contains is unzipped.
- Unzipping siRNA requires energy provided by adenosine triphosphate (ATP).

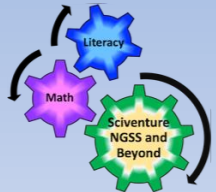


The diagram illustrates the activation of the RISC complex. On the left, a double-stranded siRNA molecule is shown bound to a protein complex (RISC). An arrow labeled 'siRNA unzipping' points to the right, where the siRNA strands are shown separated. This process is coupled with the hydrolysis of ATP to ADP + Pi, as indicated by another arrow. The resulting state is labeled 'Active RISC'.

HHMI  
HOWARD HUGHES MEDICAL INSTITUTE

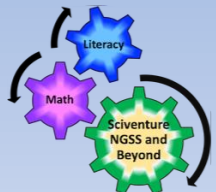
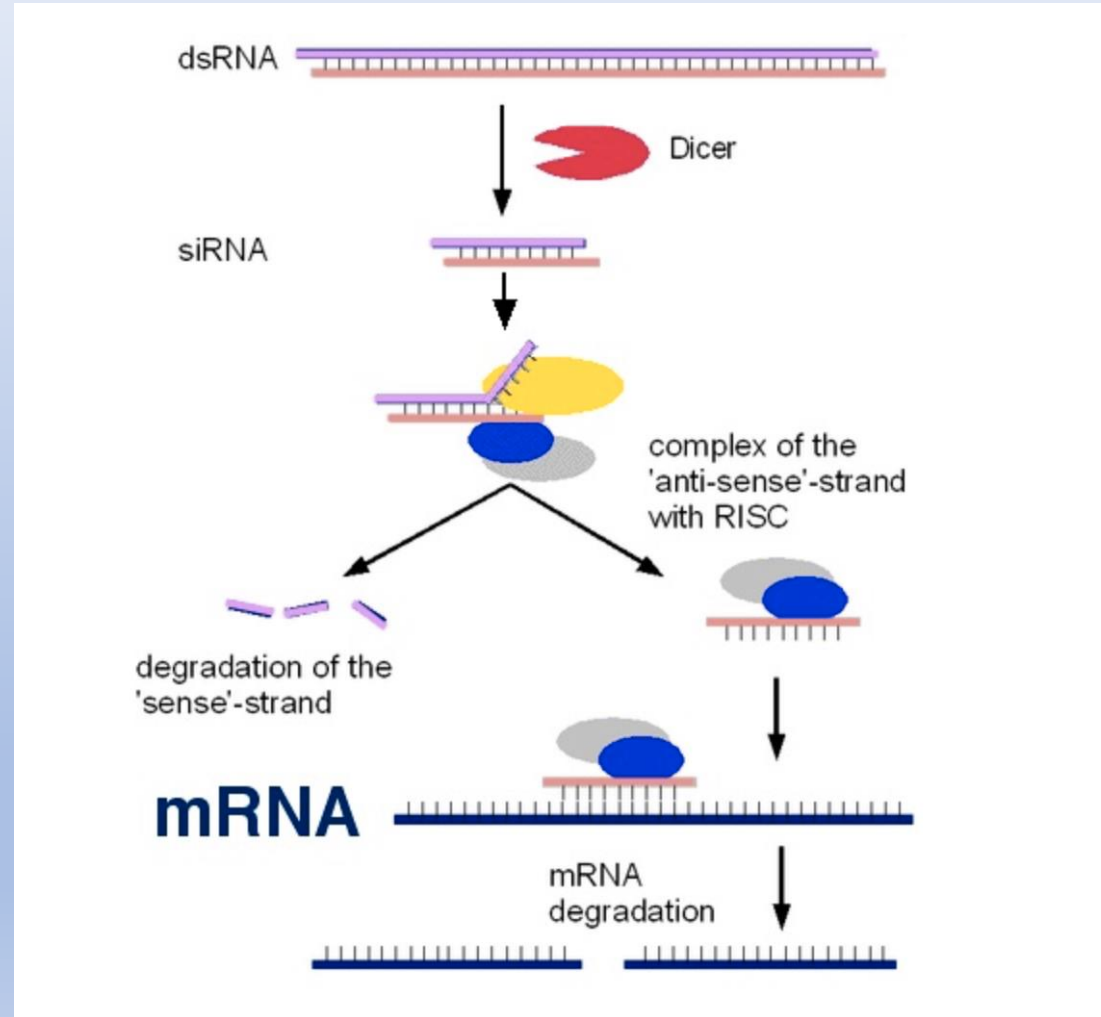
12 of 16

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# Model for Student-Scientists

Anti-sense strand to mRNA is the surviving half of the initial DS RNA



# Student-Scientists Graph Vitamin C Data

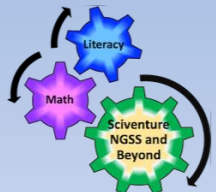
Choose Sample **Create Data** Upload File

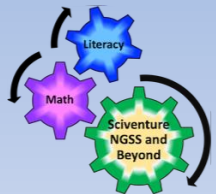
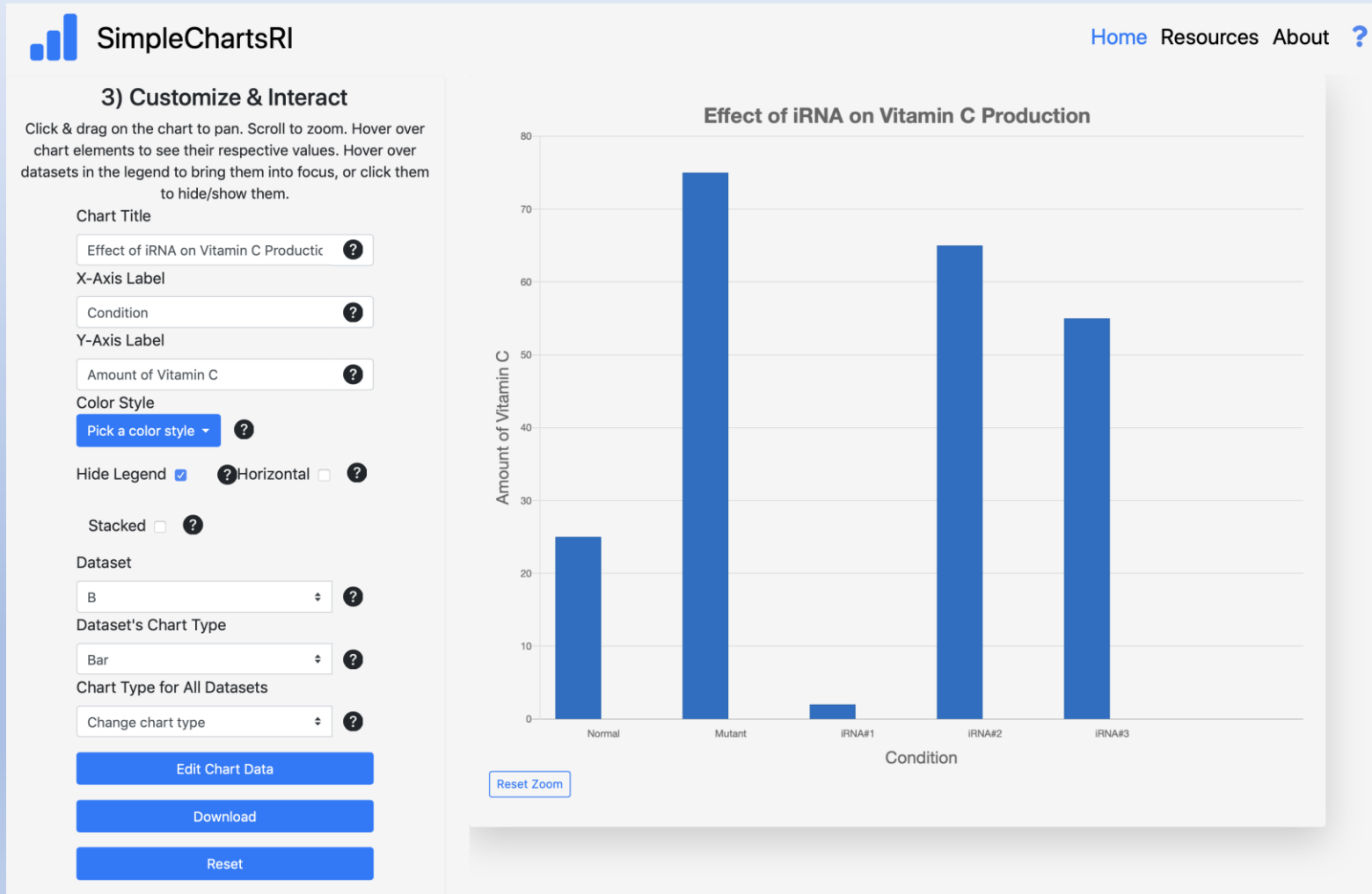
Right click the table to bring up a menu.  
For best results, delete all empty columns/rows and rename the headers (A, B, C) with the dataset's names.

	A	B	C
1	Normal	25	
2	Mutant	75	
3	iRNA#1	2	
4	iRNA#2	65	
5	iRNA#3	55	
6			

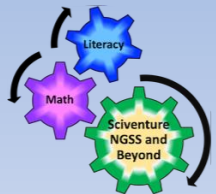
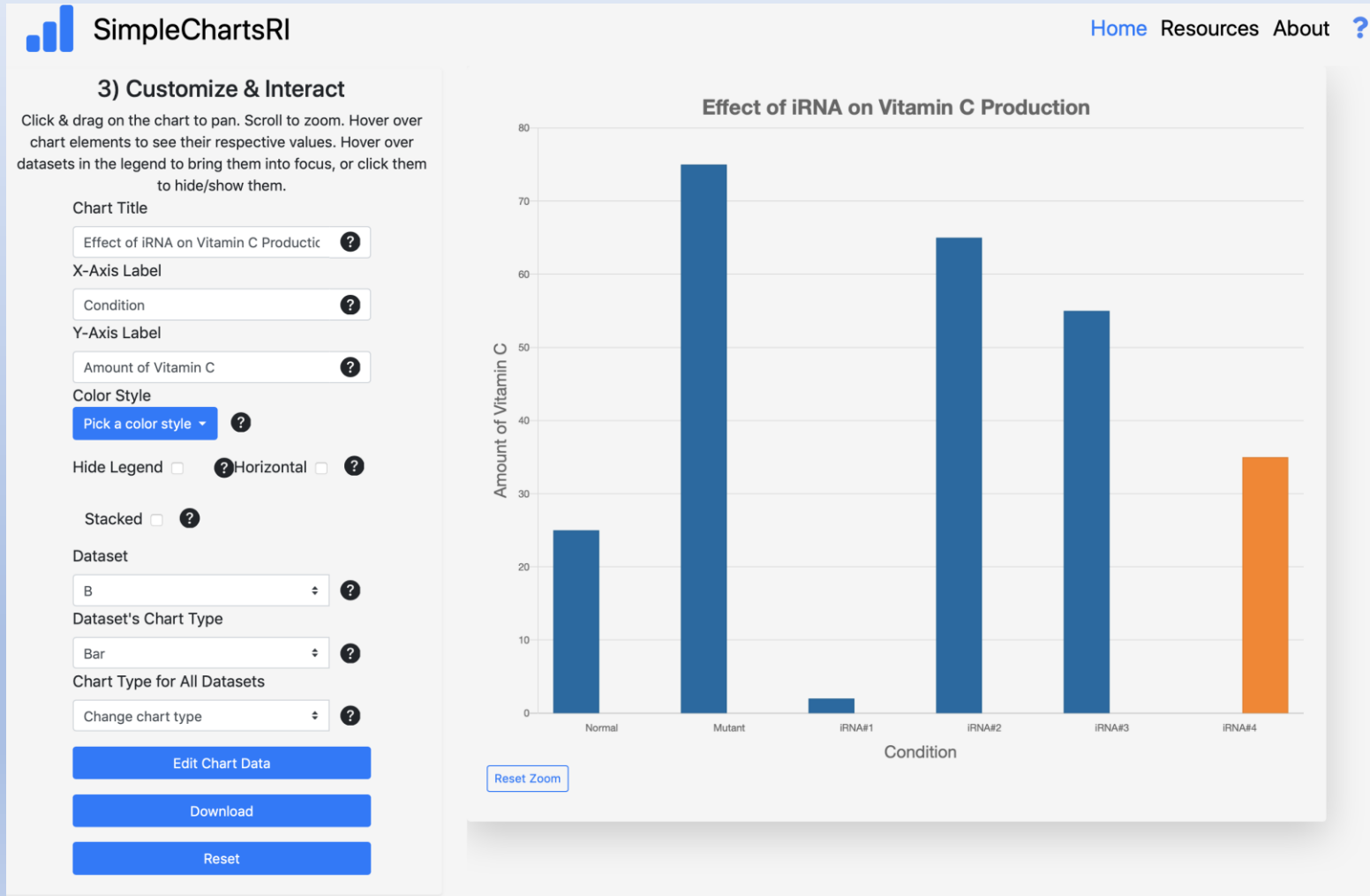
**Download** **Submit**



# Bar Graph Vitamin C Data



# Predicted Vitamin C Data for iRNA#4



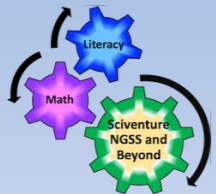
# Structure Data for iRNA #1 - 4

iRNA#1  
CCCCCCCCCCCC  
CCCCCCCCCCCC

iRNA#2  
XXCCXXXXXXXX  
XXCCXXXXXXXX

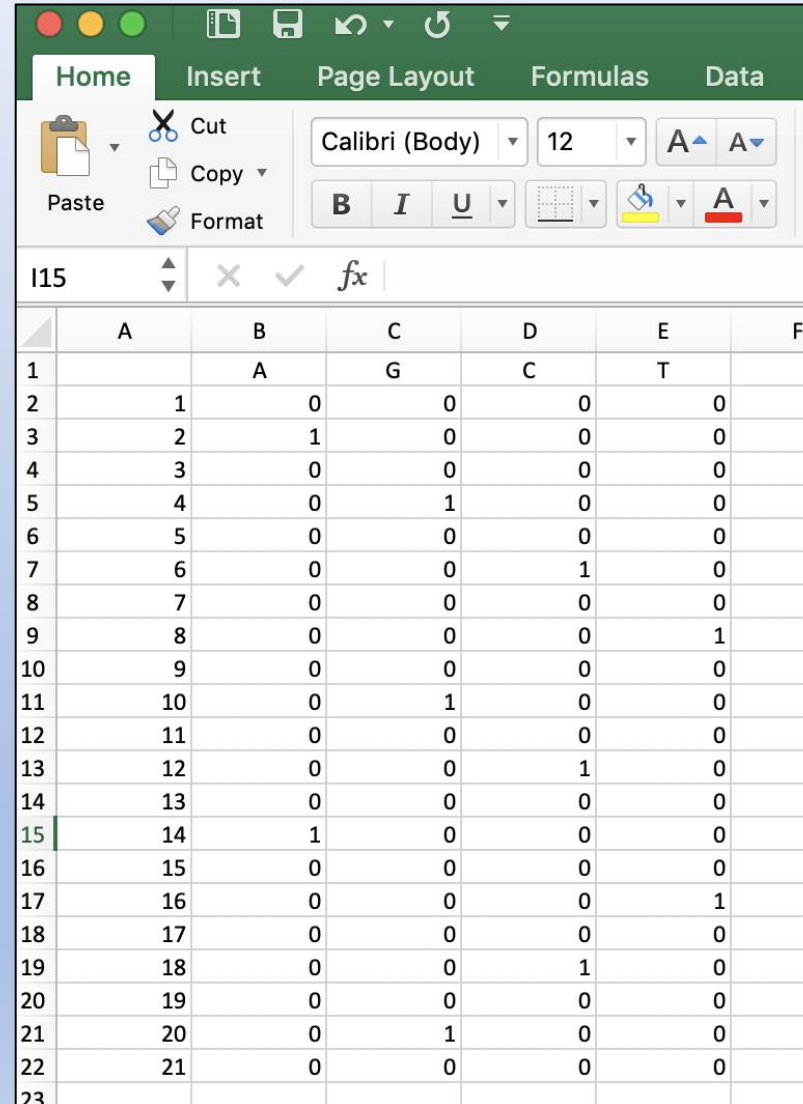
iRNA#3  
XXXXCCCXXXX  
XXXXCCCXXXX

iRNA#4  
???



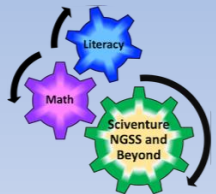


# DNA Electropherogram



The image shows a screenshot of a Microsoft Excel spreadsheet. The ribbon is set to 'Home', and the font is 'Calibri (Body)' size 12. The active cell is I15. The spreadsheet contains a table with columns A through F and rows 1 through 23. The data in the table is as follows:

	A	B	C	D	E	F
1		A	G	C	T	
2	1	0	0	0	0	
3	2	1	0	0	0	
4	3	0	0	0	0	
5	4	0	1	0	0	
6	5	0	0	0	0	
7	6	0	0	1	0	
8	7	0	0	0	0	
9	8	0	0	0	1	
10	9	0	0	0	0	
11	10	0	1	0	0	
12	11	0	0	0	0	
13	12	0	0	1	0	
14	13	0	0	0	0	
15	14	1	0	0	0	
16	15	0	0	0	0	
17	16	0	0	0	1	
18	17	0	0	0	0	
19	18	0	0	1	0	
20	19	0	0	0	0	
21	20	0	1	0	0	
22	21	0	0	0	0	
23						



# DNA Electropherogram



SimpleChartsRI

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## 1) Choose Data

Formatting matters. The quality of a visualization can only ever match the quality of its data.

[Choose Sample](#)

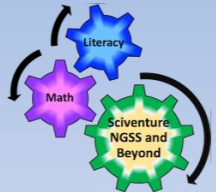
[Create Data](#)

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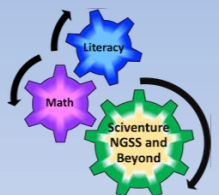
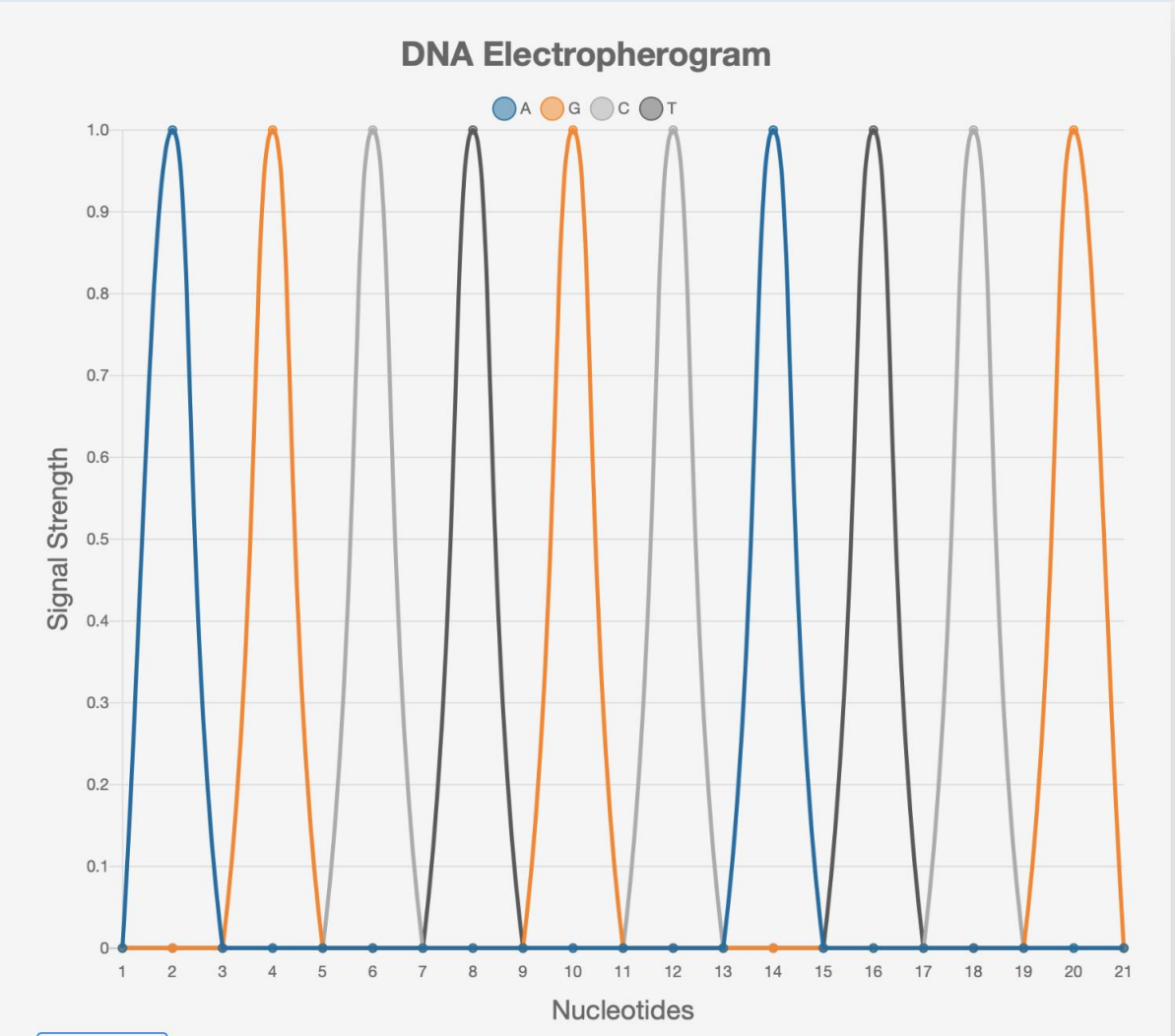
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Supported file types: csv.

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# DNA Electropherogram



# Eye of a Scientist: The Power of Data Visualization in NGSS Sciventure

Helen Flavin, Ph.D.

