

**2016 Bioscience Industry
Fellowship Project
Modules**

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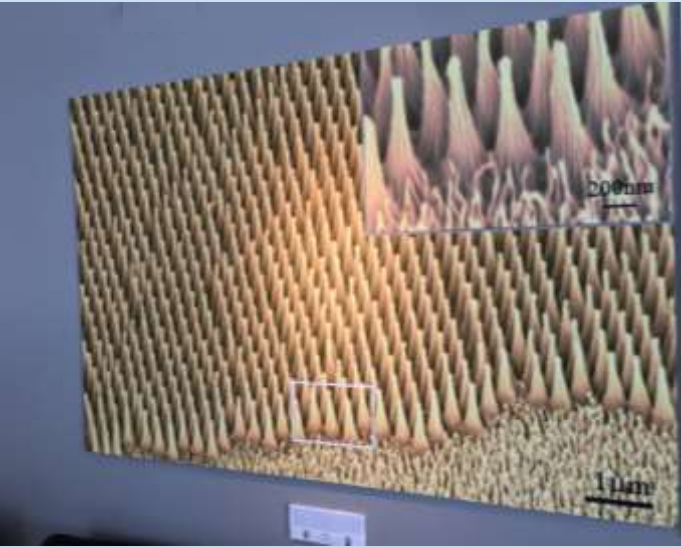
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Biotechnology, Careers, & the Future

The possibilities are endless.

Maha Gebara-Lamb, PhD

Denise Grant, MS



NSF ATE DUE
Grant #1304010



"Gives a real feel of what is going
on in the biotech industries." - BIFP fellow



**National Center for the
Biotechnology
Workforce**



June 1-24, 2016



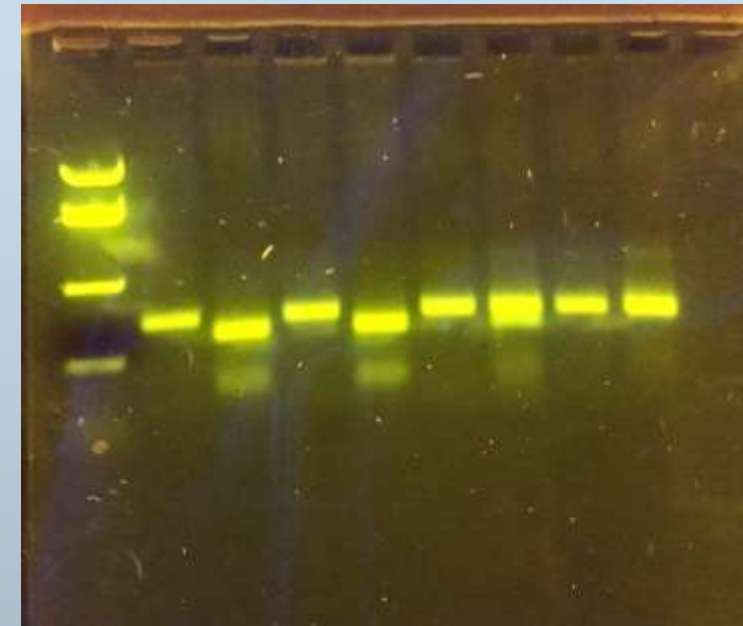
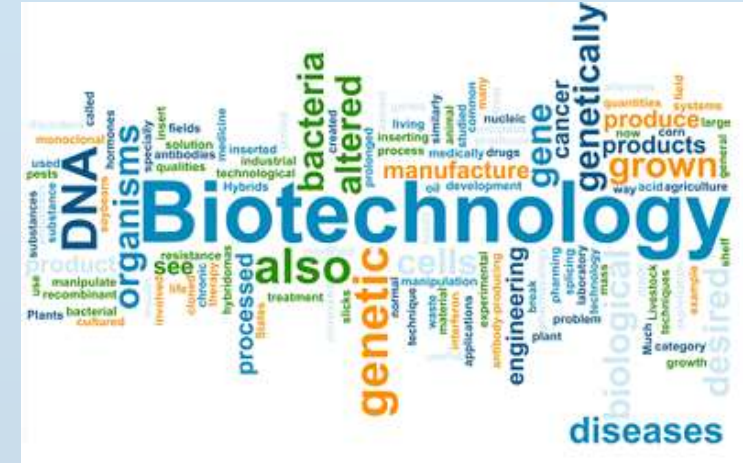
www.biotechworkforce.org

Our Goals at BIFP:

- Learn & share with students & colleagues:
 - Industry needs & where industry is going
 - State-of-the-art biotech industry & academics
- Learn about:
 - Biotechnology & biomanufacturing industries & resources
 - Careers in bioscience: skill gaps? types of jobs? internships?
- Implement at the community college level:
 - Make complex technology understandable & approachable
 - Prepare students for future of the industry

• Ultimate Aim:

Help students build their careers!



A View from the Top – Connecting the Dots

NC's strategy to develop the Biotech and Biomanufacturing Industries

Collaborative approach of policy makers, non-profit organizations, community colleges, universities, and companies

- To ensure a trained work force and a smooth pipeline from middle school to high schools, community colleges, and universities to industry
- Bring companies to North Carolina, and connect with companies to make NC a global life science leader

Some NC Educational and Industry Programs

NC Biosciences Organization
(NCBIO)

Advocacy and Policy

NC Biotechnology Center
(State Funded 501c3)

Connect Researchers

Fund Ideas

Create Jobs

B.R.I.T.E. Institute
(NC Central University)

Golden Leaf
Biomanufacturing Training
and Education Center
BTEC (NC-State)

BioNetwork
affiliated with NC CCs

Biomanufacturing and
pharmaceutical **training** consortium
AS, BS, MS, PhD, Instructors

Some NC Educational and Industry Programs

Gateway University Research
Park



The Joint School of Nanoscience
& Nanoengineering
(JSNN)

Wake Forest Innovation Quarter

World-class labs and office space to businesses, universities, and the local community.
Collaborative Partnerships – Corporate & Academic → Commercialization

Collaborative Model → Several Universities
Multidisciplinary – Scientists and Engineers
BS, MS, PhD, student internships

Ecosystem and catalyst of innovation
space, facilities companies, academic institutions,
accelerator, start ups, funding

Some CA Educational and Industry Programs



Advocacy and Policy

Connect Researchers

Help Fund Ideas

Create Jobs

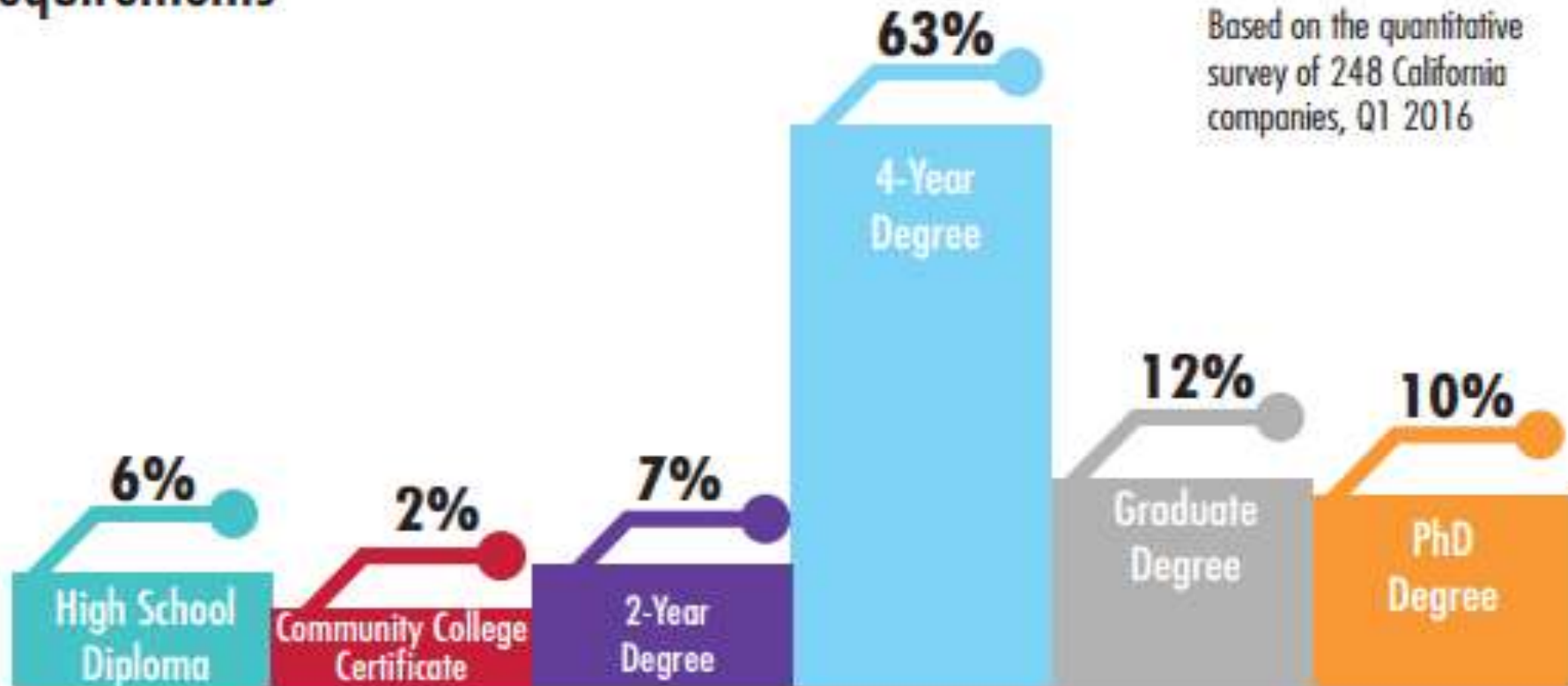
National:



Biomanufacturing and pharmaceutical **training**
AS, BS, instructors

2016 California Workforce Trends Report

Degree Requirements



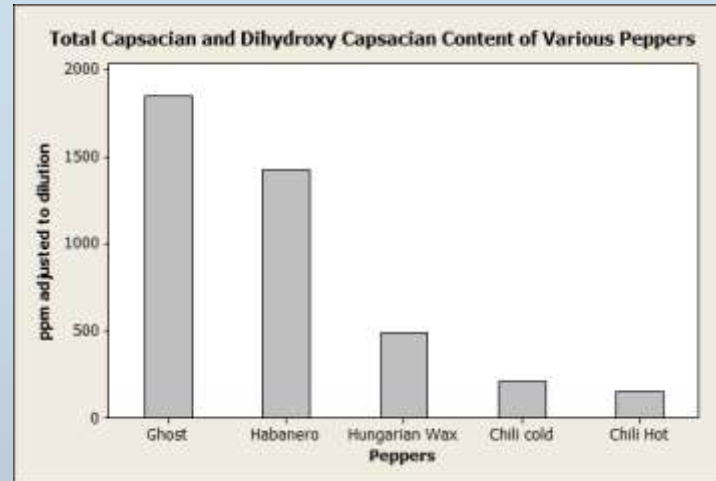
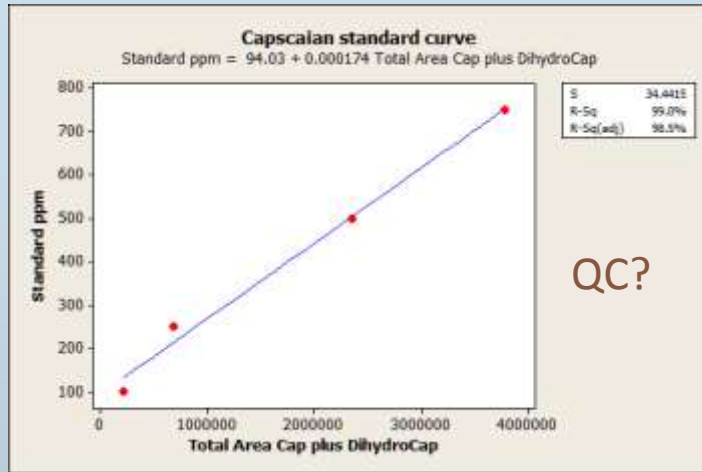
California State-Wide Initiative – Task Force Doing What Matters – For Jobs and the Economy

- Community Colleges
 - Become essential catalysts to CA economic recovery and jobs creation at the local, regional, and state levels
- **MiraCosta College – BSc Biomanufacturing starting in 2017**
 - **Biostatistics**
 - **Biomanufacturing (Biotech)**
 - **Careers**

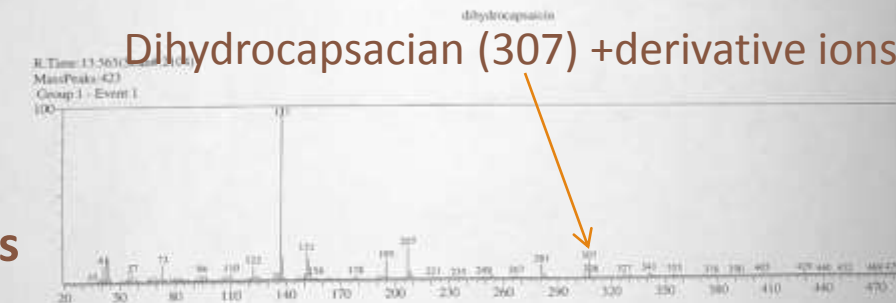
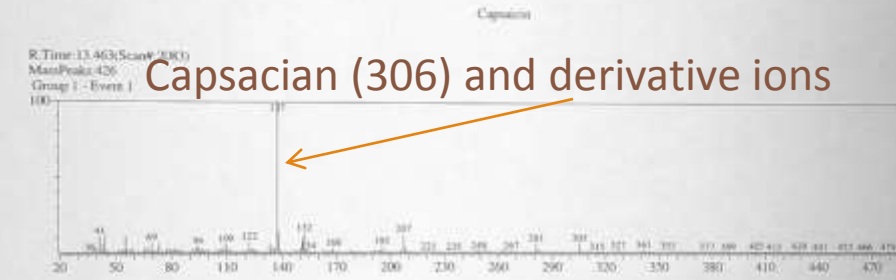
Application to Biostatistics

1. Mass Spectrometer – Quantify capsacian content in hot peppers

- By ionizing chemical species, can separate by mass/charge ratio *i.e.* measure mass



Cold Chili- Capsacian and Dihydrocapsacian



Quantitative Result Table	RTime	Area	Height	Conc. Conc. (u)
1. Capsacian	13.447	137.00	646769	264566
2. Dihydrocapsacian	13.554	137.00	213557	92424

Capsacian + DHC Standard Curve

Quantify amount (C+DHC) in Peppers

Which is the hottest Pepper?

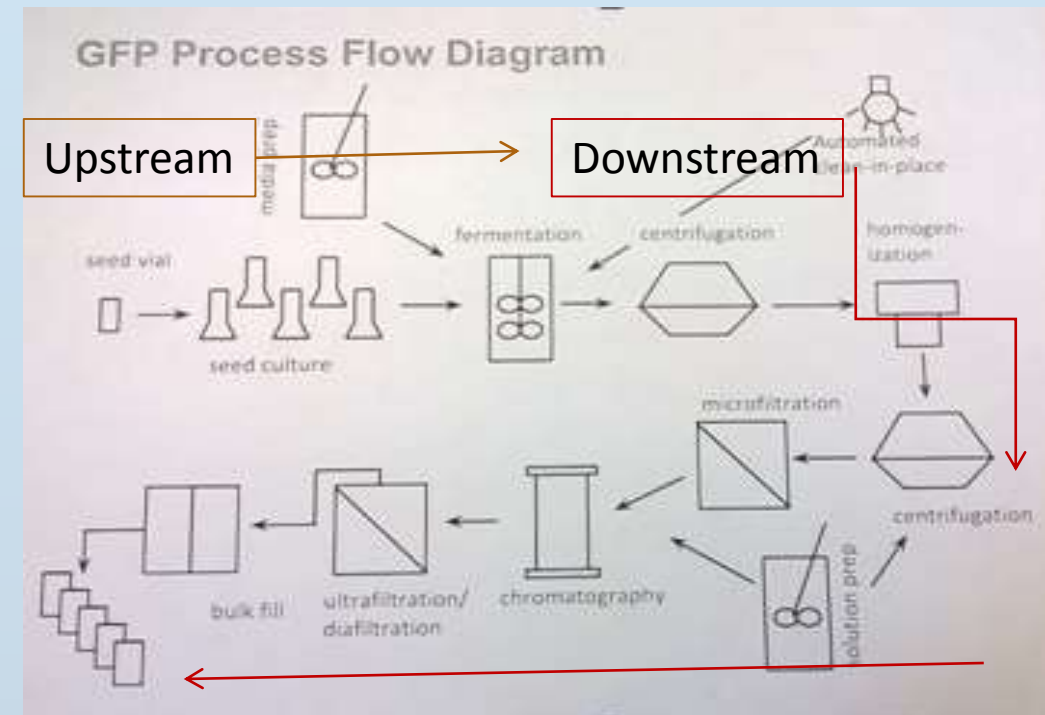
Nice meaningful example for the students

Discuss: R-squared, X and Y axis, accuracy and precision in measurement

Application to Biostatistics

2. Quality Control in Biomanufacturing

- Some insights into quality
 - *e.g.* take samples of product weight, get an average of samples
- Calculate a 95% confidence interval
 - Mean \pm margin of error



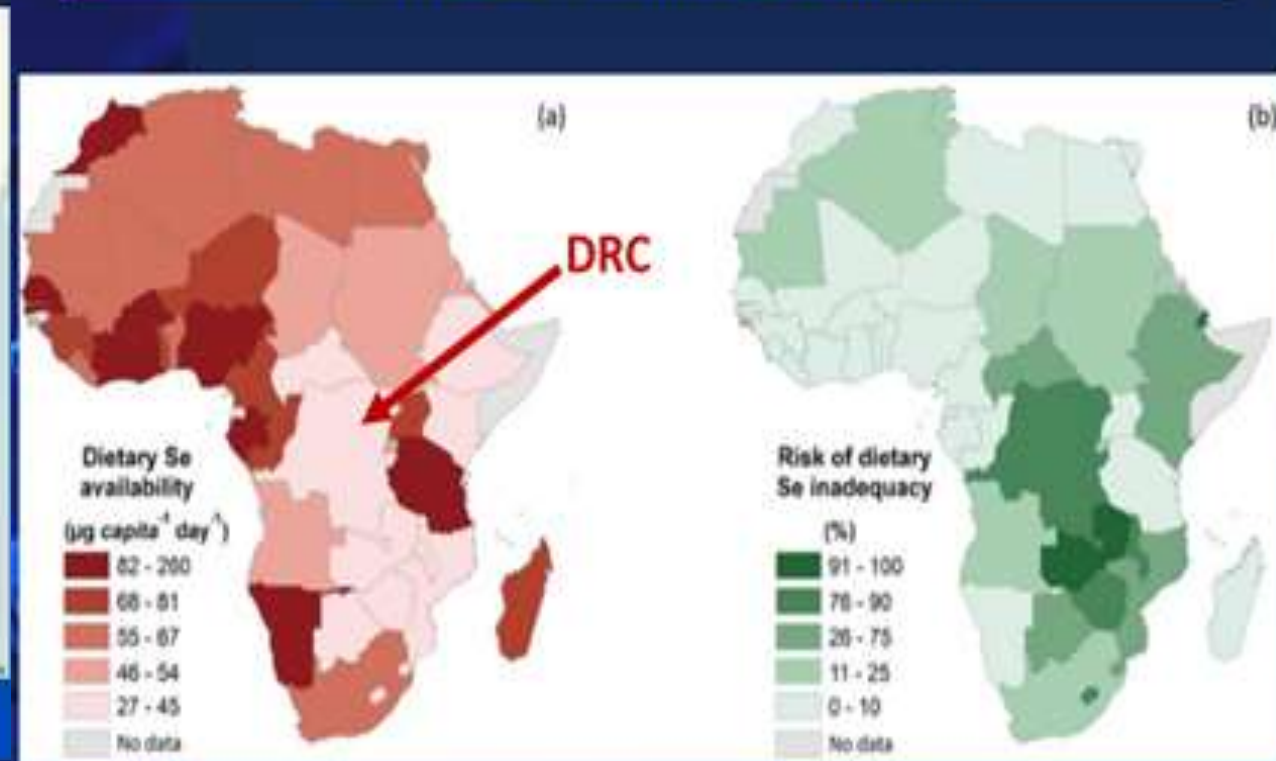
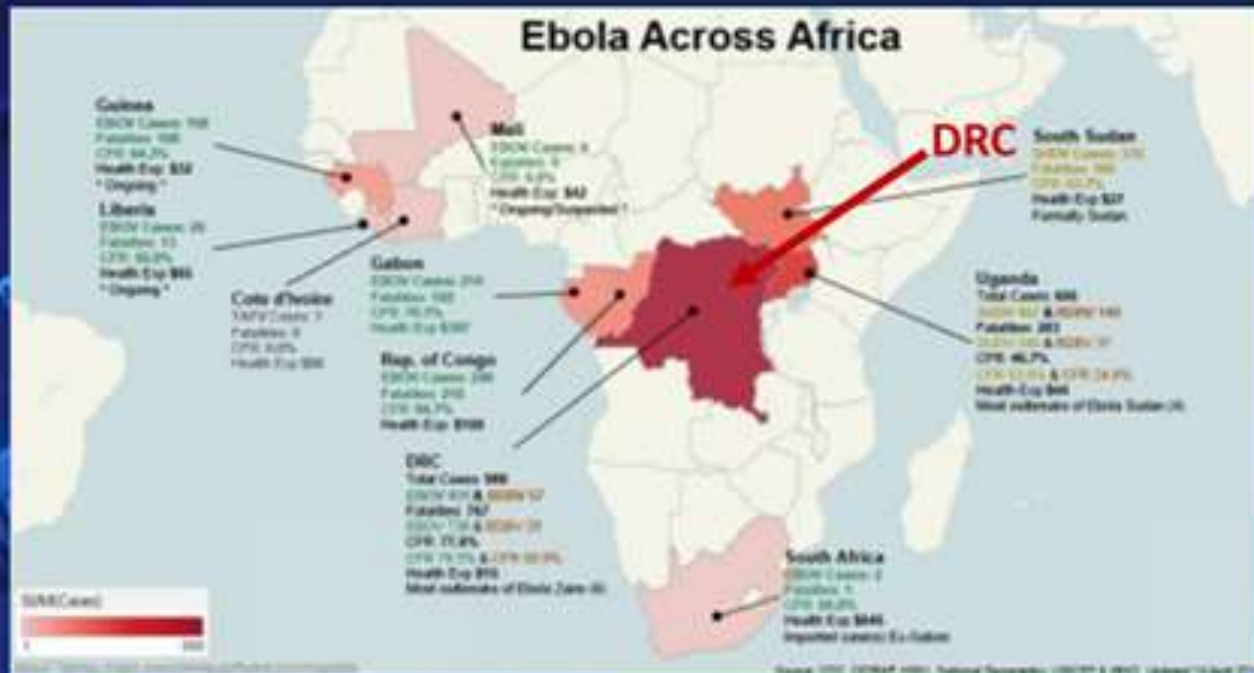
Anion Exchange Chromatography

Application to Biostatistics

3. Micronutrients and disease – correlation of Ebola to low levels of selenium

Democratic Republic of the Congo
Ex. Locus of Initial 2014 Ebola Outbreak

Democratic Republic of the Congo
Ex. Low Soil Levels of Selenium



Initial 2014 Ebola mortality rates across Africa, as of April 2014.

Ways to display data.

High correlation, discuss if can claim causation?

What does it take? What is the evidence?



JSNN



Joint School of
Nanoscience and Nanoengineering

Application of Hydroponics to Solving Micronutrient Deficiencies and Feeding the World → Vertical Farming

JSNN & Novozymes



A set of vertical farms designed for use in China

Image: Vincent Callebaut Architects

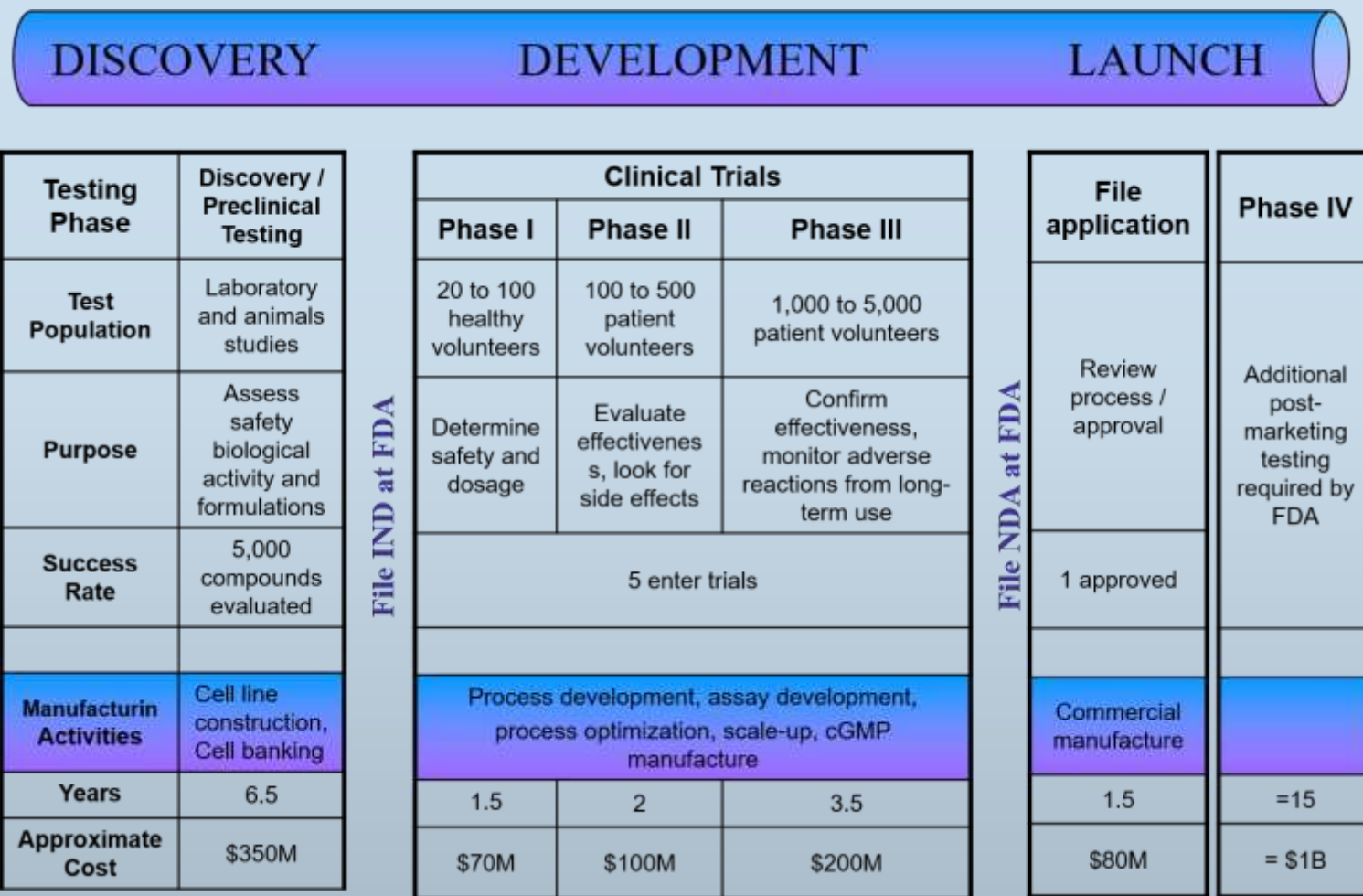


Visionary Home farm combines retirement homes and vertical urban farms

Application to Biostatistics

4. Clinical Trials

- Expanded on knowledge
- Better understanding of phases
- When INDs are submitted and intellectual property
- Regenerative medicine:
 - Small organoids and bodies on a dish → faster & better ways to perform **clinical trials** in a **dish** – to test drugs and therapies that might work in humans (personalized medicine)



Biotechnology Program at Alamance Community College

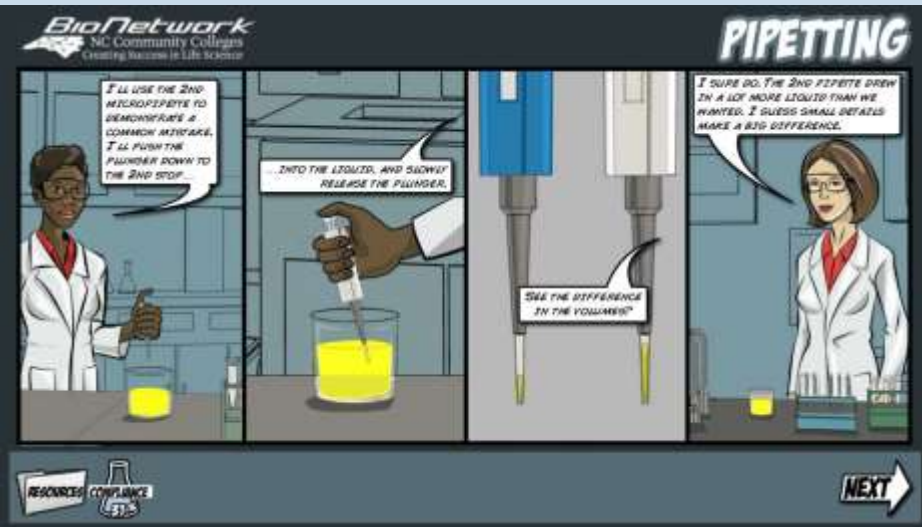
- Writing, Communications, Computers, Statistics
- General Chemistry I, Organic & Biochemistry, Analytical Chemistry
- General Biology I & II
- Microbiology, Genetics
- Cell Culture, Immunology
- Basic Lab Techniques
- Bioprocess Techniques (Biomanufacturing)
- Advanced Molecular Techniques
- Internship or Capstone
- Weekly Seminar (in development)
- *Advising*



Just-approved plan: Biotechnology
Center of Excellence

Apply New Ideas to Existing Classes

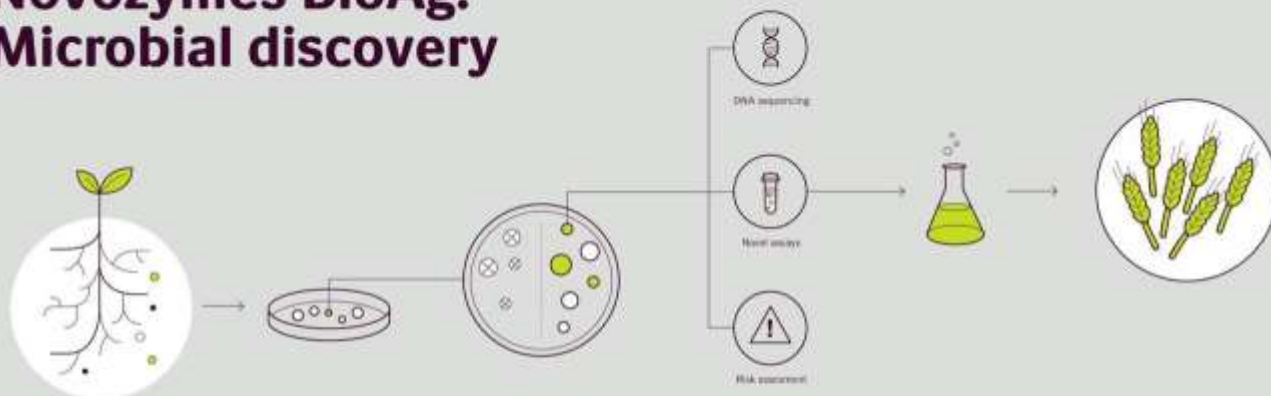
- Novel techniques & equipment + existing biotechnology courses
 - Interactive eLearning tools: pre-lab assignments from [BioNetwork](http://BioNetwork.org)
 - Pipetting, Federal Regulations, General chromatography, HPLC, Bioreactors, etc.
 - Classes: Intro to Biotech, Bioprocess, Microbiology, etc.



Prepare for the Future of the Industry

- Novel techniques & equipment + existing biotechnology courses
 - Improving agriculture with microbes: fertilizer, pesticides, nutrient sources
 - Novozymes: upstream discovery
 - Classes: General Biology II, Microbiology

Novozymes BioAg: Microbial discovery



1 Collect

Soil samples are collected from targeted fields all around the country by agronomists

2 Grow

From these samples, thousands of microorganisms are grown in special media and under special conditions

3 Identify

Pure colonies of the isolated micro-organisms are DNA-sequenced, identified, characterized and classified

4 Potential

Novel assays are developed to screen the identified microorganisms for their potential benefits

5 Testing

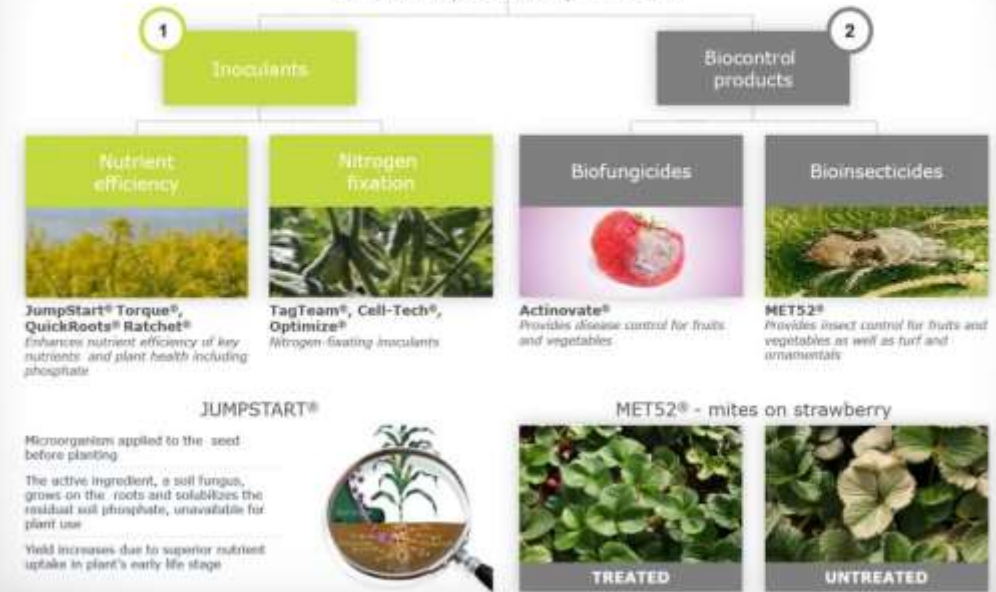
Beneficial microbes are then fermented, formulated and field tested

6 Measure

In field testing, the potential of the microbes in increasing fertility and yield and in crop protection is measured

OUR PROVEN MICROBIAL PORTFOLIO

Current product portfolio



JUMPSTART®

Microorganisms applied to the seed before planting

The active ingredient, a soil fungus, grows on the roots and solubilizes the residual soil phosphate, unavailable for plant use

Yield increases due to superior nutrient uptake in plant's early life stage



MET52® - mites on strawberry



TREATED



UNTREATED

Prepare for the Future of the Industry



JSNN



Joint School of
Nanoscience and Nanoengineering

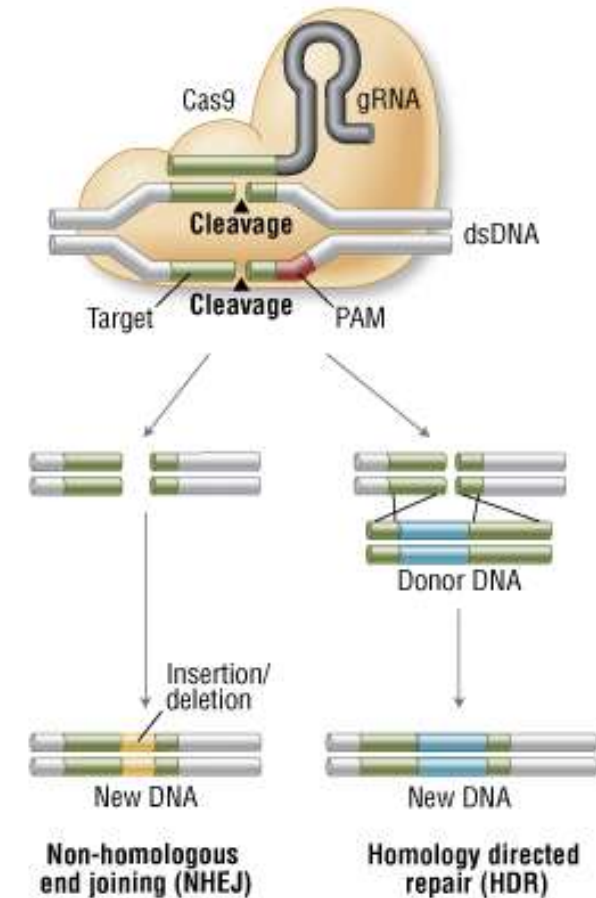
- Novel techniques & equipment + existing biotechnology courses
 - Everyday nanotechnology:
 - Air purification: titanium dioxide in ceiling tiles
 - Hydroponics: food yield, reduced space & water, & don't need rich soils
 - Nanofiberglass can stop a bullet
 - Grow brighteners into plants, also increases yield
 - New ideas: ~35 years from incubation, to innovation, to industry
 - Nanobots can do anything a cell can do
 - Antibacterial surfaces mimicked from nature
 - Tiny health monitors embedded into textiles
 - Joint School of Nanoscience and Nanoengineering
 - Classes: any/all of them!



Prepare for the Future of the Industry

- Novel techniques & equipment + existing biotechnology courses
 - Gene editing: CRISPR-Cas9
 - Editing genes like editing Word documents!
 - Cut DNA at very specific sequences in living cells
 - Allow mutations or
 - Introduce new DNA sequence
 - [June 21, 2016](#): NIH approved proposal for clinical trials using CRISPR-Cas9 to help augment T cell cancer therapies
 - North Carolina Biotechnology Center & Institute for Regenerative Medicine
 - Classes: Advanced Molecular Techniques

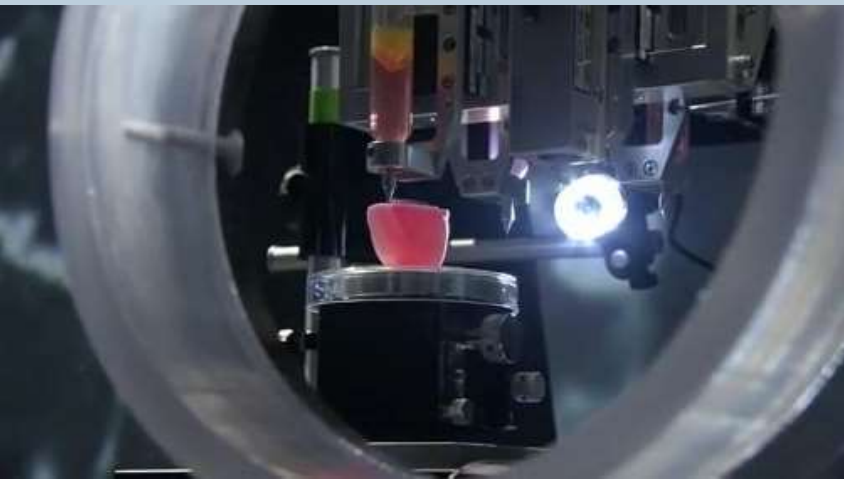
A. Genome Engineering With Cas9 Nuclease



Prepare for the Future of the Industry



- Novel techniques & equipment + existing biotechnology courses
 - Personalized medicine & tissue repair/replacement
 - Quantify (electrical resistance) effect of chemotherapy drugs on patient cells in real time
 - BRITE
 - Building organs for transplant: put cells on 3D scaffold, grow in bioreactor
 - Institute for Regenerative Medicine
 - Classes: Cell Culture



Advising

- Internship opportunities:
 - Joint School of Nanoscience and Nanoengineering
 - Biogen
 - Carolina Liquid Chemistry



Careers:

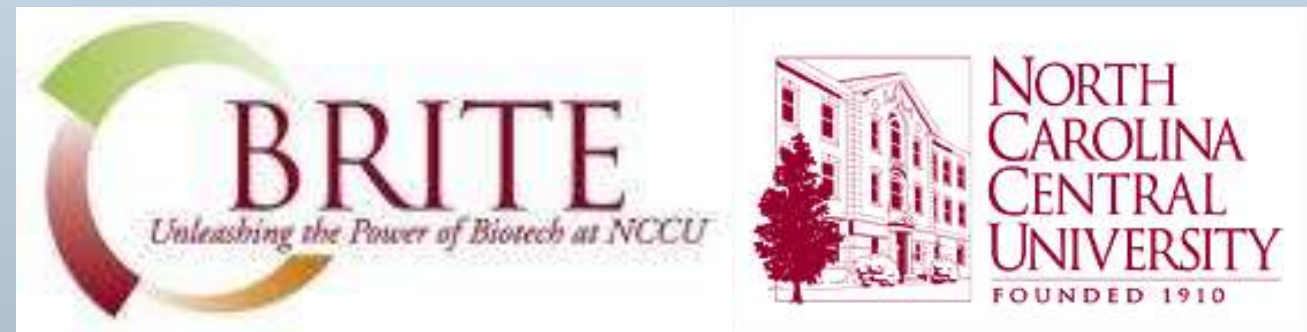
- **Internships**

- **Carolina Liquid Chemistries (Patricia Shugart COO) –** Chemistry analyzers and reagents for clinical laboratories
- Site in California- Internships at every level → Students and AWIS Colleagues



Advising

- Internship opportunities:
 - Joint School of Nanoscience and Nanoengineering
 - Biogen
 - Carolina Liquid Chemistry
- Further education:
 - ACC articulation agreement with NC Central BRITE (Biomanufacturing Research Institute & Technology Enterprise) program
 - ACC students enter as juniors
- Networking with colleagues
- Connecting graduates with careers



Careers

- Expanded our knowledge
 - Regional differences
 - Biotech & biomanufacturing
 - Different disciplines and skill levels
 - Chemists, biologists, statisticians, engineers, lawyers
 - Bioinformatics & programming
 - “Never worry about getting a job”
 - Understanding genome structure
 - Gene expression – microarrays
 - Proteomics
 - Dominant trends:
 - Gene editing (CRISPR-Cas9) & immuno-oncology
 - Skills gaps:
 - Soft skills, adaptability, exposure to ethical questions of gene editing

What Can You Do with Your Biotechnology Skills?

In the Workplace

High School Diploma

- Biochemistry
- Math
- Biology
- Physics
- Chemistry

Career Opportunities

- Animal care
- Glass washer
- Lab assistant

Salary Range*

\$14,000 - 30,000

College

- Biotechnology
- Math
- Chemistry
- Biological Sciences

Community College

Career Opportunities

- Lab technician
- Lab assistant
- Research assistant
- Media Prep
- Manufacturing

Salary Range*

\$17,000 - 48,000

University/4 yr. College

- Math
- Physics
- Chemistry
- Biological Sciences
- Chemistry
- Computer Science

Career Opportunities

- Environmental health and safety
- Patent agent
- Bioinformatics
- Research associate
- Imaging specialist

Salary Range*

\$30,000 - 70,000

Graduate School

- Masters
- Doctorate

Career Opportunities

- Medical writer
- Research Scientist
- Biotech Sales
- University Professor
- Clinical Researcher
- Associate
- Scientist
- Lab Director

Salary Range*

\$40,000 - 100,000

Additional Career Paths: Regulatory Affairs Specialist, Packaging Operator, Quality Assurance Auditor, Laboratory Assistant, Director of Environmental Health and Safety, Documentation Specialist, Patent Administrator, Biostatistician, Regulatory Affairs, Plant Breeder, Postdoctoral Fellow, Manufacturing Technician, Animal Caretaker, GREENHOUSE TECHNICIAN, Drug Experience Coordinator, Qualification Engineer, Forensic Technologist, Librarian, Glass Washer, Quality Assurance Technician, Patent, Research Assistant, Biomaterials Specialist, Animal Handler, Technical Writer, Biomaterials Specialist, Assay Analyst, Plant Manager, Criminal Identification Specialist, Fisheries Biologist, Biomedical Technician, Validation Engineer, Laboratory Technician, QUALITY CONTROL ANALYST, Administrator, Criminal Intelligence Specialist, Forensic Specialist, Genetic Counselor, Scientific Programmer Analyst, Director of Research and Development, Clinical Programmer, Buyer/Purchasing Agent, Fermentation Scientist, Entomologist, Cell Physiologist, Clinical Coordinator, Graduate School, Masters, Doctorate, Career Opportunities, Medical Writer, Research Scientist, Biotech Sales, University Professor, Clinical Researcher, Associate, Scientist, Lab Director.

Health and Safety Specialist

- Manufacturing Assistant
- Media Prep Technician
- Clinical Data Specialist
- Greenhouse Worker
- Biochemical Development Engineer
- Sterilization Technician
- Ethologist
- Laboratory Assistant
- Manager of Manufacturing Human Resources

Phytopathologist

- Public Relations
- Manufacturing Associate
- Paleontologist
- Director of Genetic Engineering
- Forest Pathologist
- Biofuels Expert

Environmentalist

- Vitaculturist
- Animal Breeder
- Technician
- Vegetable Scientist
- Marine Biologist

Documentation Specialist

- Animal Husbandry Technician
- R & D Chemist
- Environmental Health and Safety
- Patent Agent
- Bioinformatics
- Research Associate
- Imaging Specialist

Pharmacologist

- Parasiologist
- Dietitian
- Fish Culturalist
- Wildliffe Conservation
- Instrument/Calibration
- Medical Entomologist
- Biotechnologist
- Microbial Culture
- Collection Curator
- Genetic Counselor
- Ichthyologist
- Criminalist

Footnote: *Annual median of the worker are available from the Bureau of Labor Statistics Bureau of Economic Analysis. This poster was created by the California Community College System, Sacramento campus, Biotechnology Institute, 5000 Houston, Yuba College, 2487 Ferguson Road, Yuba, CA 95991, (916) 548-8977, email: info@yuba.edu. www.cccnet.edu © Fall 2002. Sacramento Community College District © 2002.

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- California:** California State University, Fullerton, CA 92632, (714) 773-3333, www.fullerton.edu
- Florida:** Florida State University, Tallahassee, FL 32306, (904) 943-1111, www.fsu.edu
- Illinois:** Northern Illinois University, DeKalb, IL 60115, (815) 753-1111, www.niu.edu
- Michigan:** Eastern Michigan University, Ypsilanti, MI 48197, (313) 487-1111, www.emu.edu
- North Carolina:** North Carolina State University, Raleigh, NC 27695, (919) 751-1111, www.ncsu.edu
- Ohio:** Ohio State University, Columbus, OH 43210, (614) 292-1111, www.osu.edu
- Texas:** Texas A&M University, College Station, TX 77701, (409) 845-1111, www.tamu.edu
- Virginia:** Virginia Polytechnic Institute, Blacksburg, VA 24061, (540) 231-1111, www.vpi.edu
- Washington:** Washington State University, Pullman, WA 99164, (509) 335-1111, www.wsu.edu
- Wisconsin:** University of Wisconsin, Stevens Point, WI 54481, (715) 339-1111, www.uwsp.edu
- Wyoming:** University of Wyoming, Laramie, WY 82031, (307) 766-1111, www.uwyo.edu

Thank
you!



Innovation in the Biosciences: An Interdisciplinary Approach



Peter Kim

Sarah Johnson

June 23, 2016



Biology

Engineering

Chemistry

English

Science

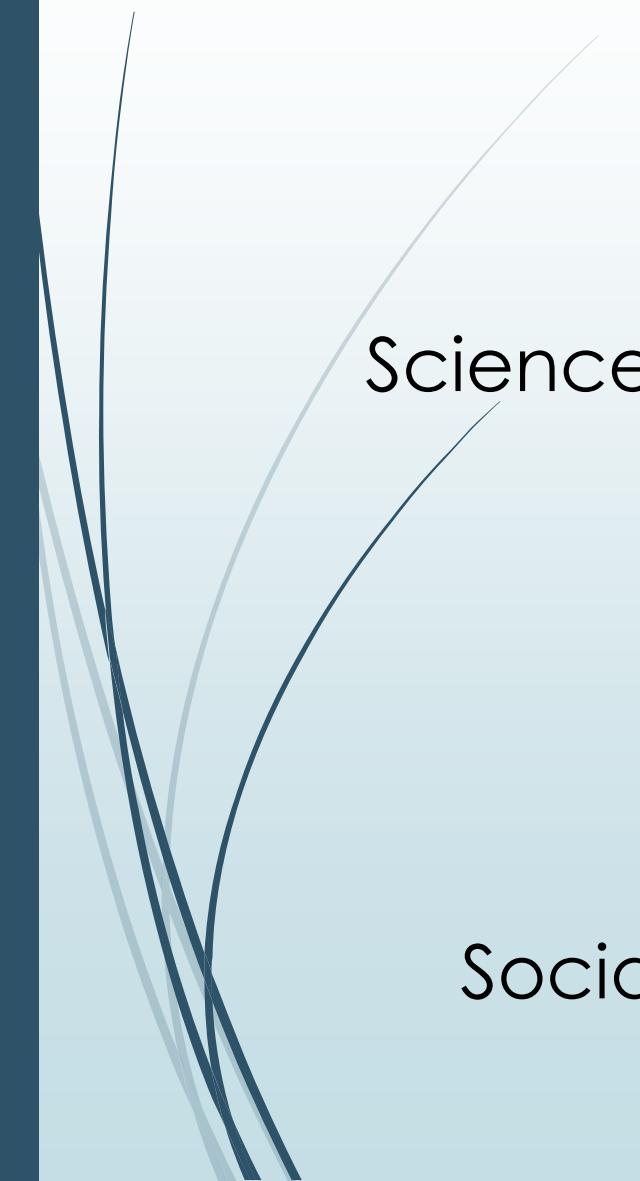
Biotechnology


Math

Technology

Social Sciences

Art





“Being an innovator is not just about solving problems. It’s about solving problems no one else sees.”

- Phil McKinney

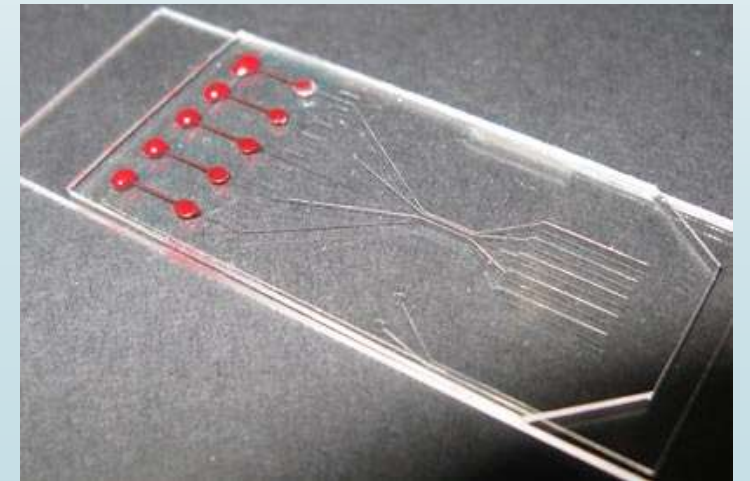


Why the Biosciences?

- Profitable Industry
- Investment (Education, R&D)
- Cutting-edge Research
- Growth of Industry (Jobs)
- Career Options

Profitable Industry

- ▶ NC Bioscience industry = \$73 Billion/yr
- ▶ Musculoskeletal disease: Direct cost in 2012 = \$796 Billion
- ▶ Blood tests-on-a-chip: Represent >\$1 Trill market opportunity/yr
- ▶ Biogen: \$10.8 Bill in revenue (2015)
- ▶ Novozymes: 48% share of \$3.8 Billion/yr industry
- ▶ 2013 Global Animal Health Sales: \$22.9 Bill (Pharma = \$7.75 Bill)



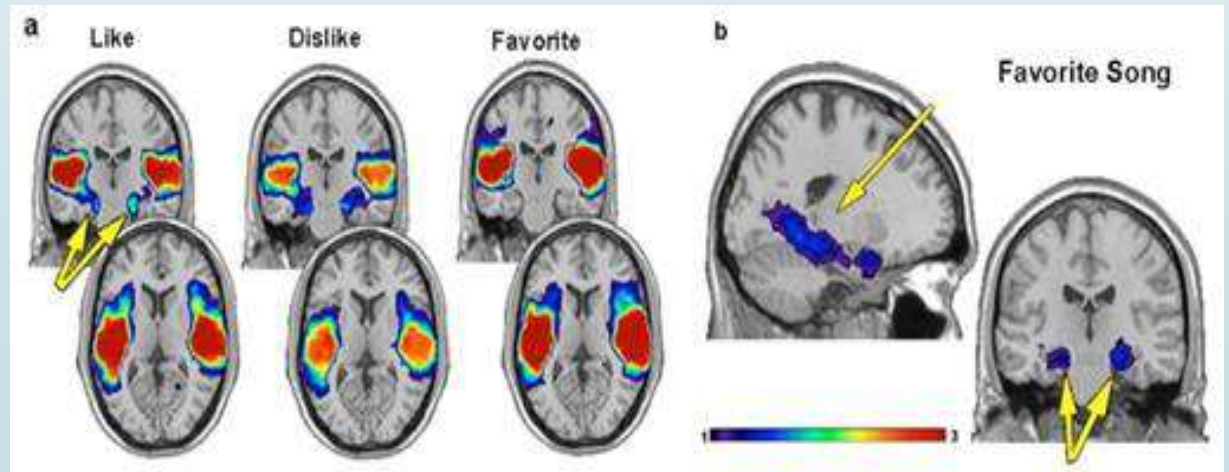
Investments in Educ. + R&D

- ▶ Joint School of Nanoscience & Nanoengineering
 - ▶ \$56.3 M Facility
 - ▶ High-cost of instruments (He-ion microscope, TEM, FIBM/FESM)
- ▶ BRITE (NCCU)
 - ▶ \$17.8 M Facility
 - ▶ \$5.6 M in lab equipment
- ▶ Piedmont Pharmaceuticals
 - ▶ >\$12 M spent annually on R&D
- ▶ vTv Therapeutics
 - ▶ High cost of drug development



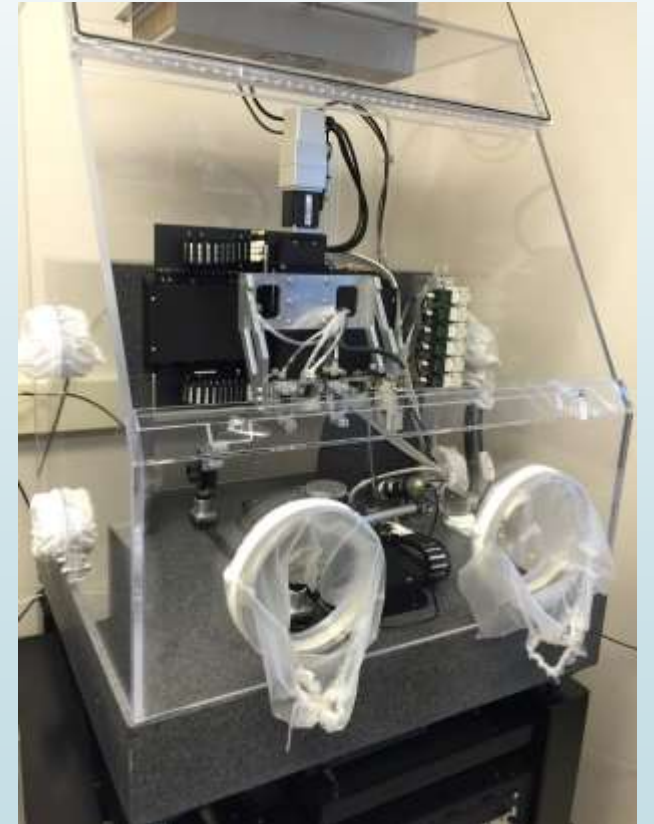
Cutting-Edge Research

- ▶ Joint School of Nanoscience & Nanoengineering (JSNN)
 - ▶ Functional Nanomaterials
 - ▶ Sustainable Functional Hydroponics
 - ▶ Effect of Music on Brain



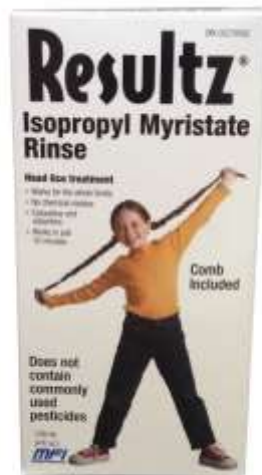
Cutting-Edge Research


- ▶ Wake Forest Institute for Regenerative Medicine (WFIRM)
 - ▶ 3D Organ Printing
 - ▶ Skeletal muscle tissue engineering (Dr. Criswell)
 - ▶ Bioartificial Pancreas to treat diabetes (Dr. Opara)



Cutting-Edge Research

- ▶ vTv Therapeutics
 - ▶ Azeliragon (Alzheimer's)
- ▶ Piedmont Pharmaceuticals
 - ▶ Resultz (human head lice)
 - ▶ Resultix (tick spray)

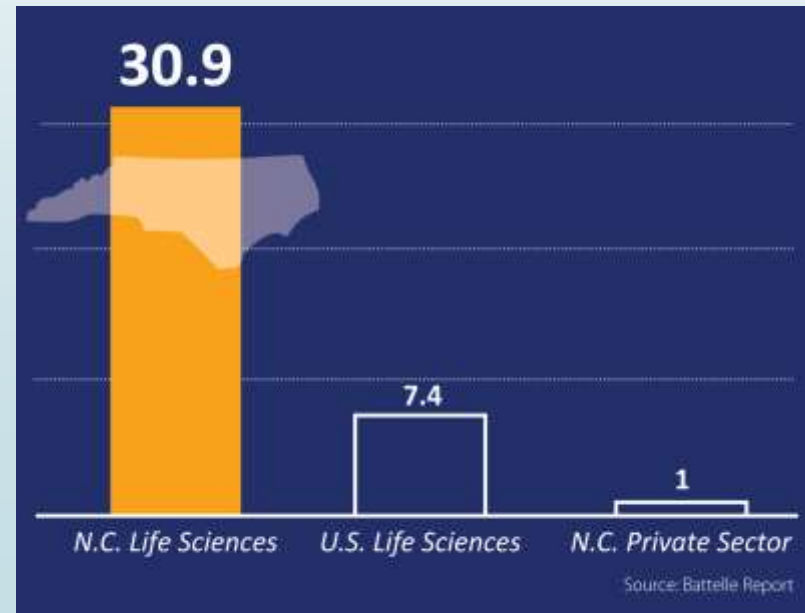


	ALZHEIMER'S DISEASE PROGRAM AZELIRAGON Targeting RAGE (Antagonist of the Receptor for Advanced Glycation Endproducts)

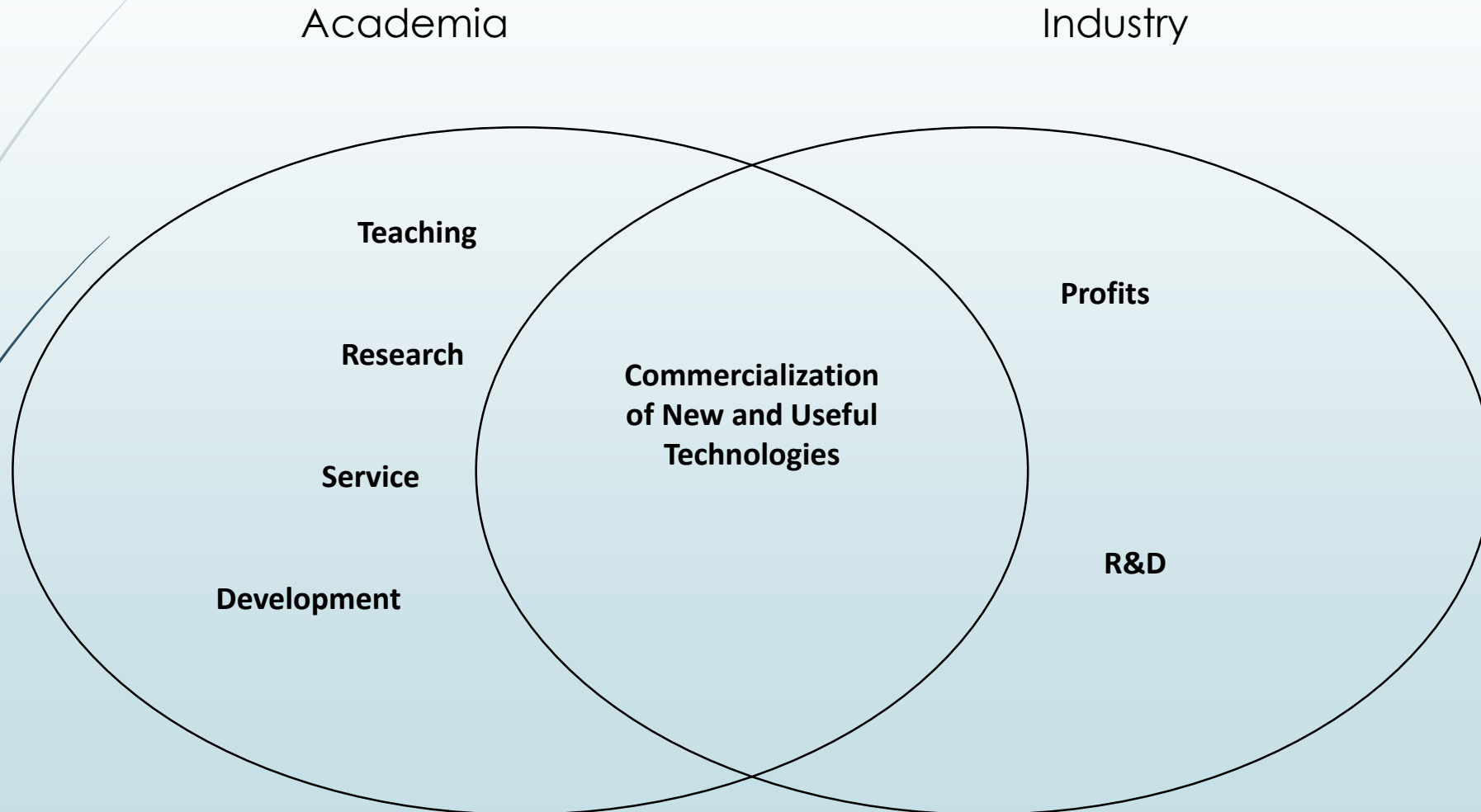


Growth of Industry

- ▶ 600+ life science companies
 - ▶ R&D (363), Contract Research & Testing (128), Production & Manufacturing (105)
- ▶ 30.9% job growth (4x national avg.)
- ▶ Average salary = ~\$80,000
- ▶ Return on investment (grants / loans)



Career Options






Industry Shapes Education



Institutions focusing on Bioscience Education

- ▶ Forsyth Tech
- ▶ BRITE (NC Central Univ.)
- ▶ Joint School of Nanoscience & Nanoengineering (UNCG & NC A&T)
- ▶ Rowan-Cabarrus CC
- ▶ Wake Forest Institute for Regenerative Medicine
- ▶ BioNetwork Capstone Center (WTCC) @ NC State Univ.
- ▶ Alamance CC
- ▶ A-B Tech CC



How can we apply Biotechnology
across all curricula?

A decorative graphic on the left side of the slide. It features a dark blue vertical bar at the top left, a black arrow pointing right, and several thin, curved lines in shades of blue and grey that sweep across the page.

Biotechnology in Core Subjects

- Math
- Social Sciences
- English

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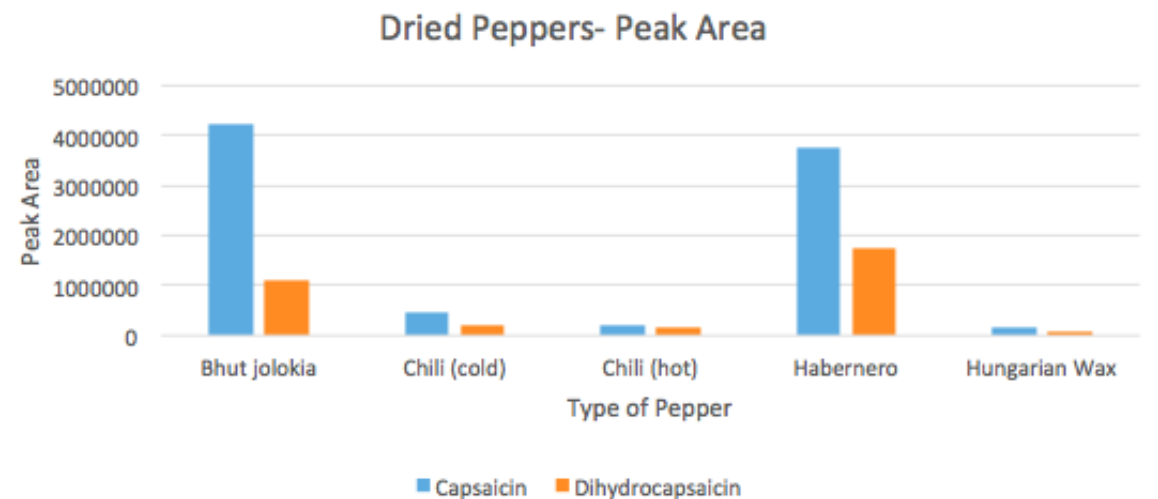
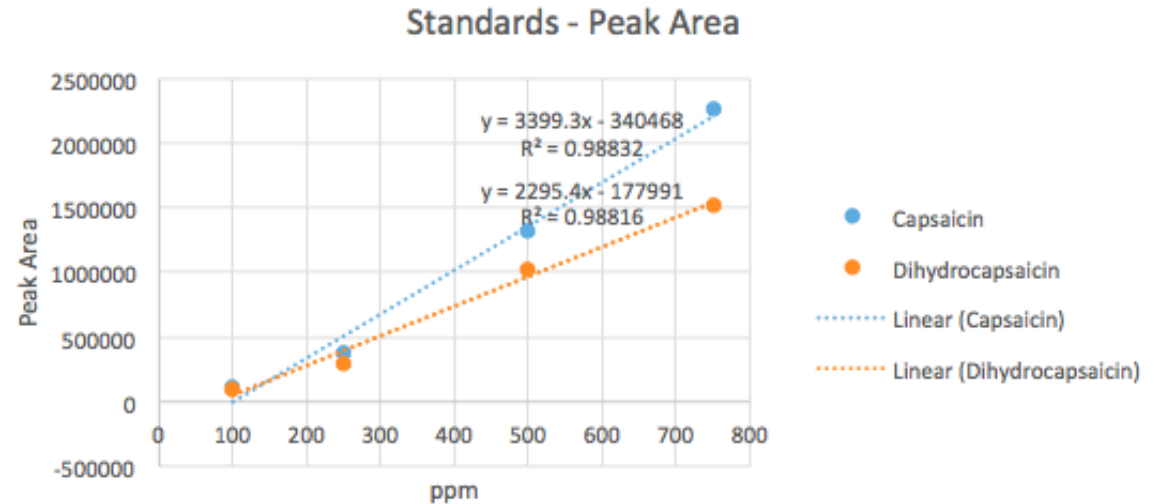
Mathematical Concepts in Biotech

- Several math concepts in biotech industry/education such as:
 - Algebra
 - Exponential/linear graphs
 - Conversions (scale up)
 - Trigonometry

Analysis of Capsaicin and Dihydrocapsaicin in Dried Peppers using GC-MS (RCCC)

Analysis of Capsaicin and Dihydrocapsaicin in Dried Peppers using GC-MS

Sample	Peak Area		Peak Height	
	Capsaicin	Dihydrocapsaicin	Capsaicin	Dihydrocapsaicin
100	112618	101070	61164	29311
250	382254	300883	237266	120033
500	1319163	1030869	858021	425078
750	2262947	1527808	1395652	719254
Bhut jolokia	4214200	1123960	2675020	419430
Chili (cold)	448769	213557	284569	92424
Chili (hot)	213809	147144	126858	61585
Habenero	3765515	1747360	2352865	585495
Hungarian Wax	146785	64935	86550	31085



A dark blue arrow points to the right from the left edge of the slide. Below it, several thin, curved lines in shades of blue and grey sweep across the left side of the slide.

Social Science in Biotechnology

- ▶ Societal relationships and the role they play in industry
 - ▶ Demographics
 - ▶ Geography
 - ▶ Civics
 - ▶ Law
 - ▶ History

A dark grey arrow points to the right from the left edge of the slide. Below it, several thin, curved lines in shades of blue and grey sweep across the left side of the slide.

English in Biotechnology

- ▶ Preparing students for comprehension and interpretation
 - ▶ Technical Writing
 - ▶ Academic Writing
 - ▶ Grants
 - ▶ Standard Operating Procedure (SOP)




Optional Assignments in English, Social Science, & Math

- ▶ English
 - ▶ Newspaper article
 - ▶ Podcast
 - ▶ Creative writing
- ▶ Social Science
 - ▶ Research history of global epidemic in last 100 years
 - ▶ Social/Ethical Debate
 - ▶ Mock Trial
- ▶ Mathematics
 - ▶ Epidemic simulation and statistical analysis
 - ▶ Population tracking



Sample Integration Project

- Theme: “Creating a Healthier School”
- Assignment: Develop and implement a change in your institution that will lead to a healthier student population
- Possible focus: nutrition, sanitation, etc.
- Integration of Biotech in the following disciplines:
 - Mathematics: research & statistical analysis
 - Social Science: demographics & socioeconomic influence
 - English: news release, SOP



*“Education is the most powerful
weapon which you can use to
change the world.”*

- Nelson Mandela

2016 BIFP Fellows





Special Thanks

- ▶ National Science Foundation
- ▶ Forsyth Tech
- ▶ Novozymes
- ▶ BRITE @ NCCU
- ▶ Joint School of Nanoscience & Nanoengineering
- ▶ Rowan-Cabarrus Community College
- ▶ DHMRI @ NC Research Campus
- ▶ Carolina Liquid Chemistries
- ▶ Wake Forest Institute for Regenerative Medicine
- ▶ Piedmont Pharmaceuticals
- ▶ High Point Clinical Trials
- ▶ vTv Therapeutics
- ▶ Center for Design Innovation
- ▶ Biogen
- ▶ NC Biotech Center
- ▶ BioNetwork Capstone Center (Wake Tech CC) @ NCSU
- ▶ Alamance Community College
- ▶ BioNetwork (A-B Tech CC)

THE CELL AND BIOTECHNOLOGY NSF-ATE MODULE BIFP 2016

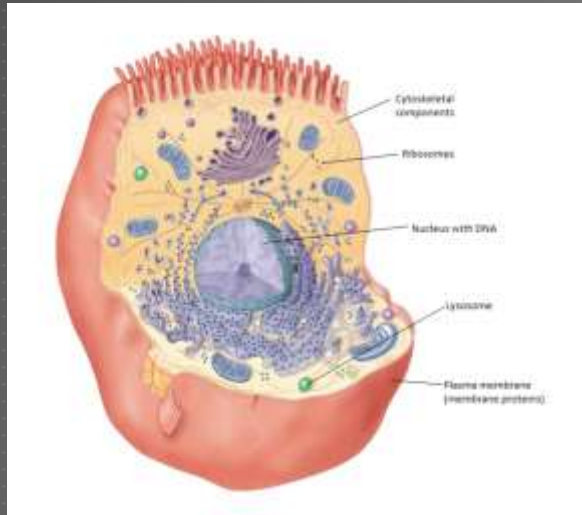
Patricia Clinard Alfing, MS

Alphonse Mendy, MS

THE CELL AND HOW IT IS USED IN BIOTECHNOLOGY

- ▶ The cell is the basic structure of every living organism.
- ▶ Biotechnology harnesses cellular and biomolecular processes to develop technologies and products that help improve our lives and the health of our planet.
- ▶ Modern biotechnology provides breakthrough products and technologies to combat debilitating and rare diseases, reduce our environmental footprint, feed the hungry, use less and cleaner energy, and have safer, cleaner and more efficient industrial manufacturing processes.
- ▶ <https://www.bio.org/what-biotechnology> -Biotechnology Innovation Organization

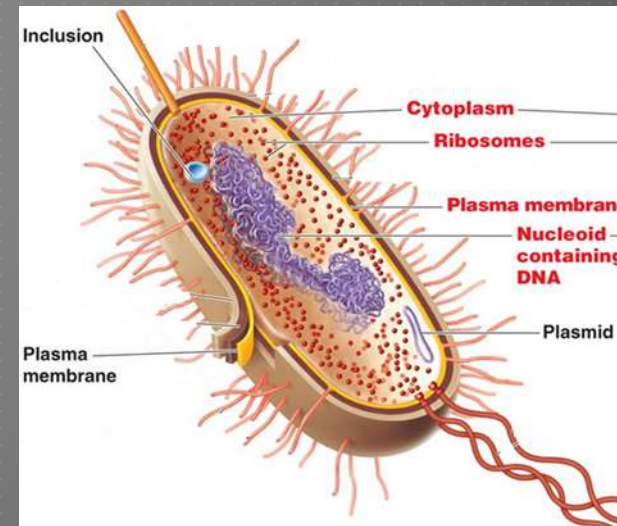
EUKARYOTE VS. PROKARYOTE



The eukaryotic cell is made up of membrane bound components including the **nucleus (DNA)**, **lysosome**, and secretory vesicles. Other components include the plasma membrane, **cytoskeleton**, ribosomes, and proteins.

Prokaryotic cells do not have membrane bound components, but do have ribosomes, **inclusion bodies (inclusions)**, and cytoplasm which holds **DNA** and **plasmids**, which are other DNA pieces.

On both prokaryotes and eukaryotes, there are **membrane proteins** that are involved in recognition and immune response.



PCR AND GEL ELECTROPHORESIS

- ▶ What is PCR?

- ▶ Polymerase Chain Reaction

- Making copies of DNA using DNA and enzymes (proteins)

- ▶ What is DNA?

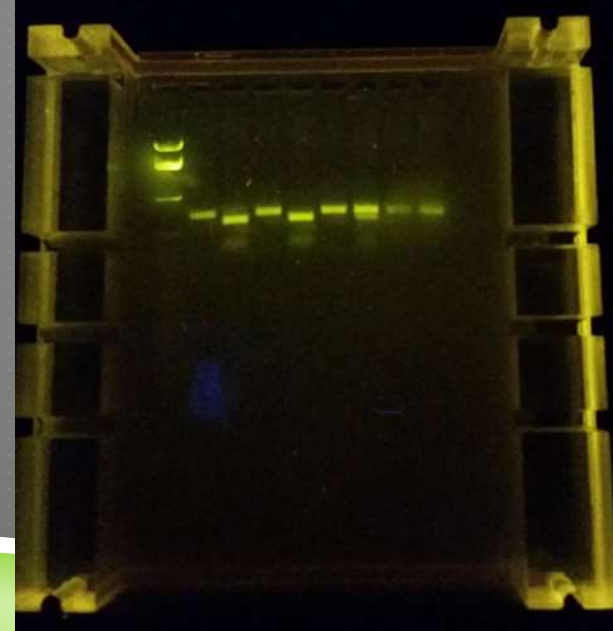
- Deoxyribonucleic acid

- A chemical within the cell that codes for everything that cell or organism can do

PCR AND GEL ELECTROPHORESIS

Isolation of DNA

- ▶ Solutions
 - ▶ Cells
 - ▶ Tools for measurement
-
- ▶ What is needed to perform PCR and Gel Electrophoresis?
 - ▶ PCR machine
 - ▶ Enzymes
 - ▶ DNA
 - ▶ Metrology materials



Metrology

- The scientific study of measurements
- Also known as the science of weights and measure
- It is one of the most ancient sciences

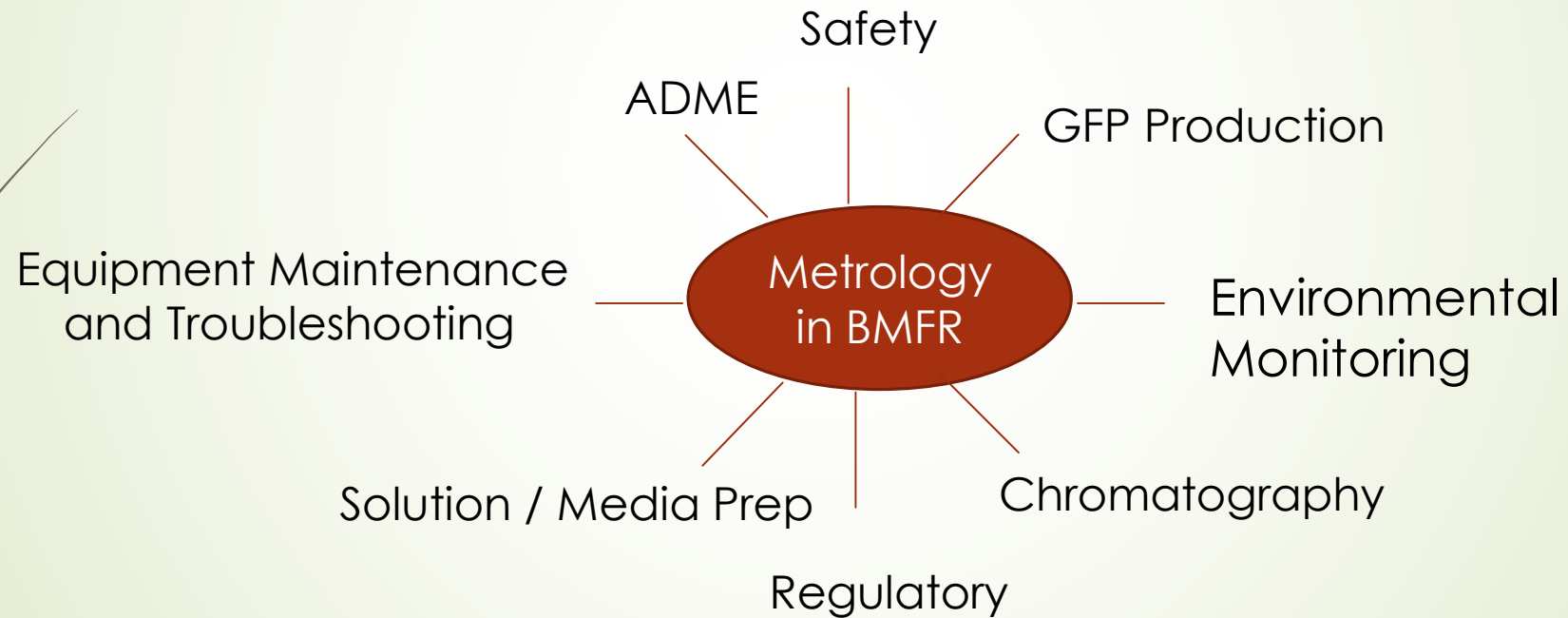


Uses of Metrology

- It is integral in the fields of :
 - Biotechnology
 - Biomanufacturing
 - Engineering
 - Commerce
 - Construction



Significance of Metrology in Biomanufacturing



Solution and Media Preparation

- It involves the weighing of solutes, measuring of liquids like penicillin, calf serum, and media
- The use of the appropriate units ensures proper media mix
- Ensures right dosage for patients who may receive oral doses, IM injections, or IV preparations



Environmental Monitoring

- ▶ Passive monitoring
 - ▶ Tryptic soy agar plates used for production run monitoring
 - ▶ Measure number of particulate matter in a given area and overall lab space
- ▶ Active monitoring
 - ▶ Particulate air monitoring
 - ▶ Surface monitoring
 - ▶ Touch plates, swabs and contact plates





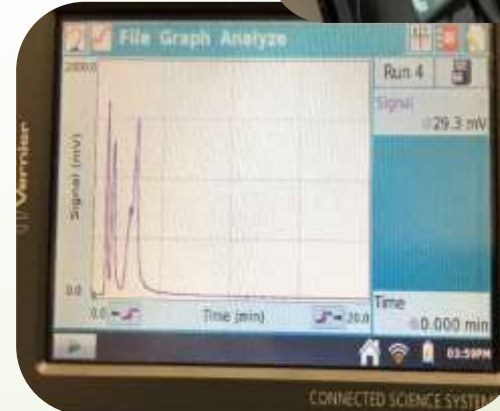
Regulatory

- ▶ The Quality control and assurance department of a company and the FDA are responsible for product safety
- ▶ QC monitor clean rooms, and production areas through the combine use of monitoring techniques:
 - ▶ Active monitoring
 - ▶ Passive monitoring
 - ▶ Surface monitoring
- ▶ Testing of raw materials and products

Chromatography

- ▶ It is method for separating solid, and liquids based on physical and chemical attributes
 - ▶ Separation of dyes
 - ▶ Separation of volatile solvents
 - ▶ Separation of Capsaicinoids
- ▶ Accurate sample preparation is basis for good results
- ▶ Knowledge of materials being separated will speed up the setup process for the separation
- ▶ Understanding the relationship between temperature, and pressure will enhance separation and quantification of analytes
- ▶ Analyses of raw data to quantify results

	Run 1	Run 2	Run 3	Run 4	Run 5
Start Temperature (°C)	120	120	80	50	50
Hold Time (Min)	10	10	10	10	10
Ramp Rate (°C/min)	1	1	1	10	5
Final Temperature (°C)					
Hold Time (Min)					
Total length					
Pressure (kPa)					



GFP Production

- An understanding of metrology is important in the production of GFP using a fermentation tank
- Knowing the projected day of product harvest will help determine when to seed the starter culture
- Metrology allow a scientist to decide when to harvest cells in fermentation based on the monitoring the following metabolites:
 - Sodium
 - Potassium
 - Lactose
 - Glucose
 - Ammonium
 - Glutamine



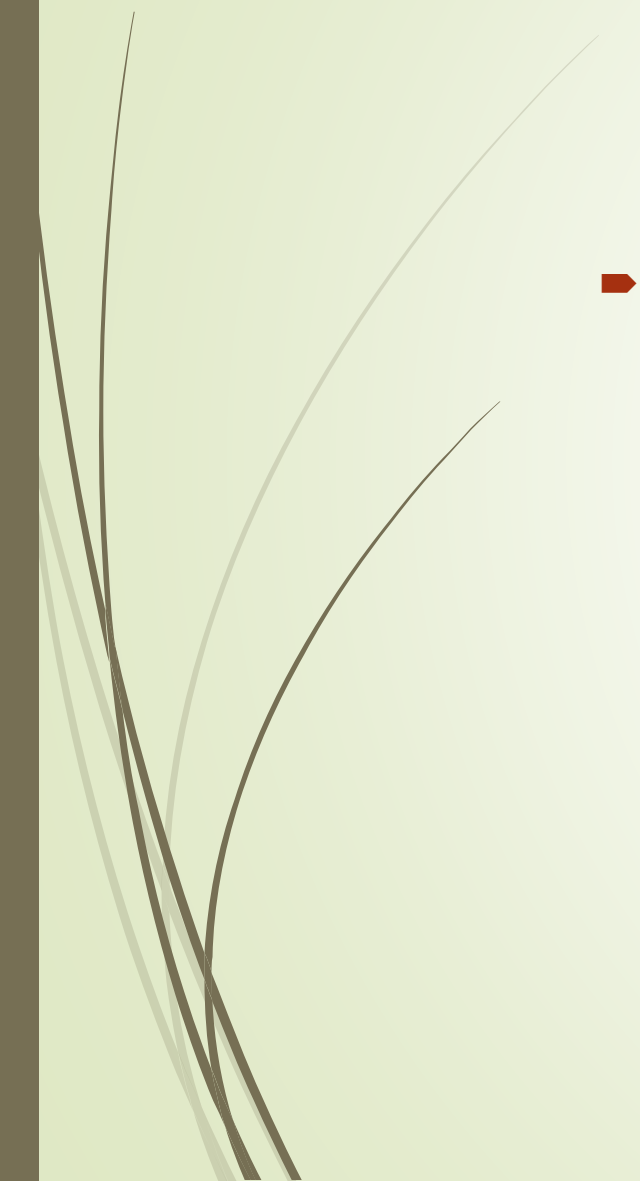
Safety

- ▶ Measurement of the degradation of an API in a drug formulation using HPLC determines the shelf-life of a drug
- ▶ This protects patients from taking medication with reduced efficacy
- ▶ Metrology makes it possible to actively monitor a room using forced air particulate matter counting





ADME

- ▶ Metrology makes it possible to formulate an oral dose, monitor its pharmacodynamics and pharmacokinetics, and its rate of excretion
- 

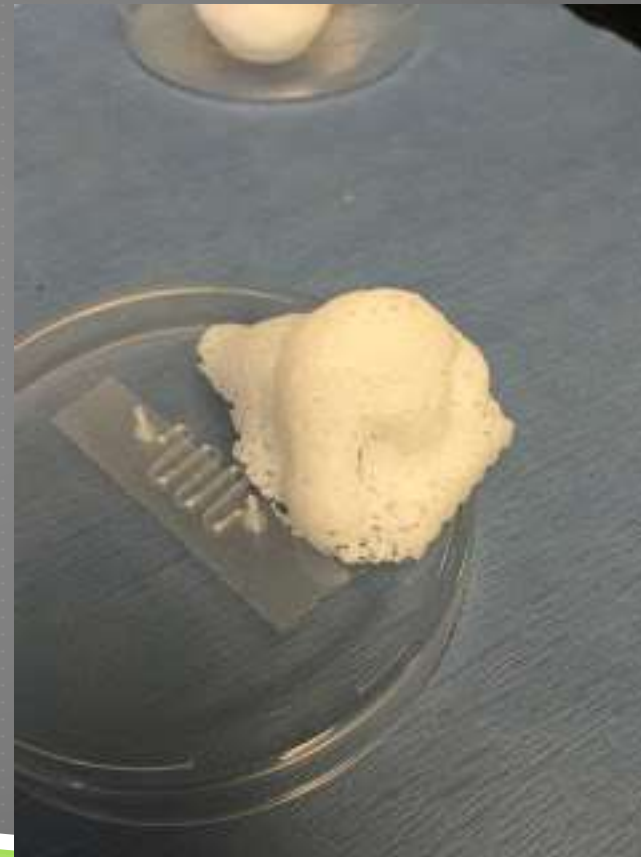
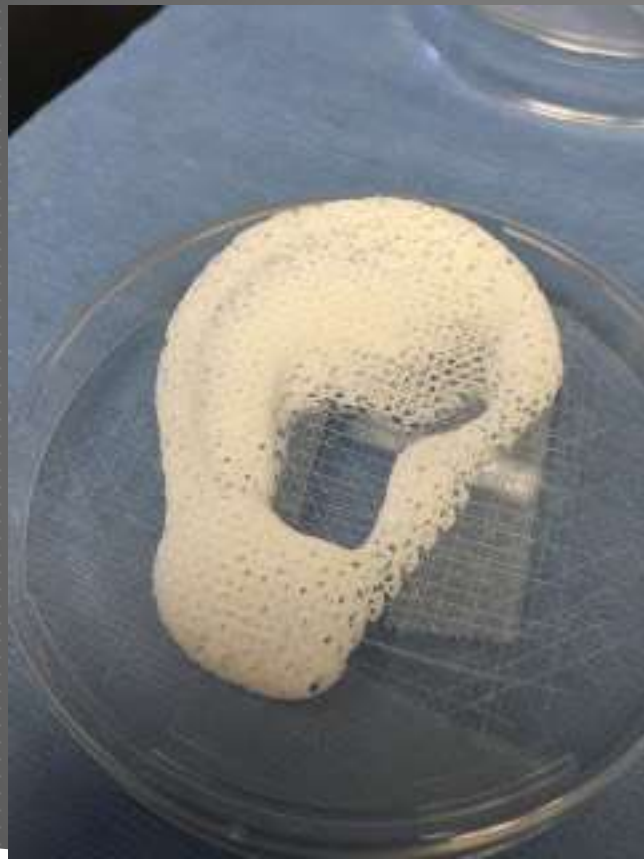
METROLOGY AND CELL BIOSCIENCE



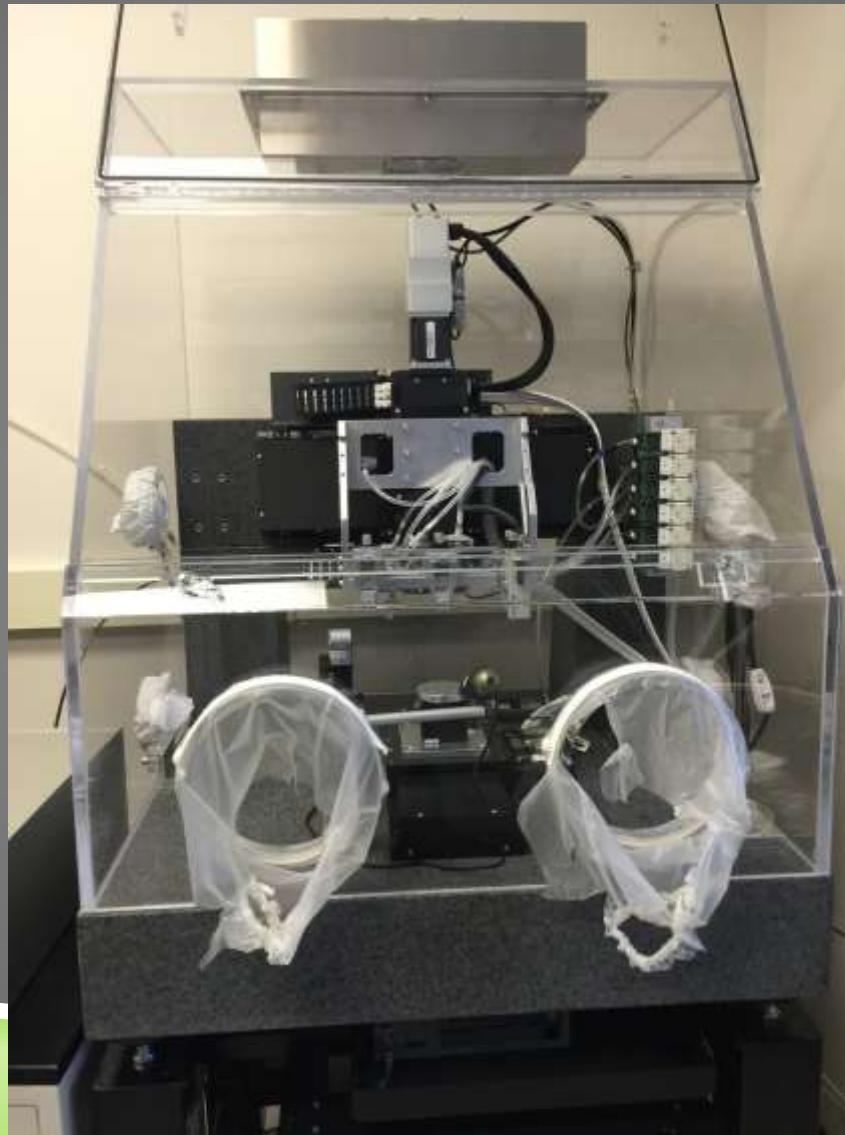
CYTOSKELETON LIKE/EXTRACELLULAR MATRIX COMPONENTS-WFIRM

- ▶ 3D printing builds body parts or scaffolds to grow body parts.
- ▶ Biological 3D printing involves printing that uses cells as ink, requiring a structure to build upon. The structure to build on is like the cytoskeletal proteins within the cell or the extracellular matrix that is outside of the cell.
- ▶ Can also be used to test drug candidates in a more thorough manner than cell culture

SCAFFOLDS FOR 3D BIOPRINTING



3D BIOPRINTING MACHINE



LYSOSOMAL DISEASES –B.R.I.T.E AT NCCU

- ▶ What is the lysosome?

- ▶ A membrane bound organelle that helps to keep the cell clean by breaking down and recycling components and chemicals as well as microorganisms

- ▶ What are lysosomal diseases?

The lysosomal storage disorders (LSD) are a group of about 50 diseases that are characterized by an accumulation of waste products in the lysosomes, resulting in the formation of large intracellular vacuoles

Although individually rare the lysosomal storage disorders as a group have a frequency of about 1/8000 live births

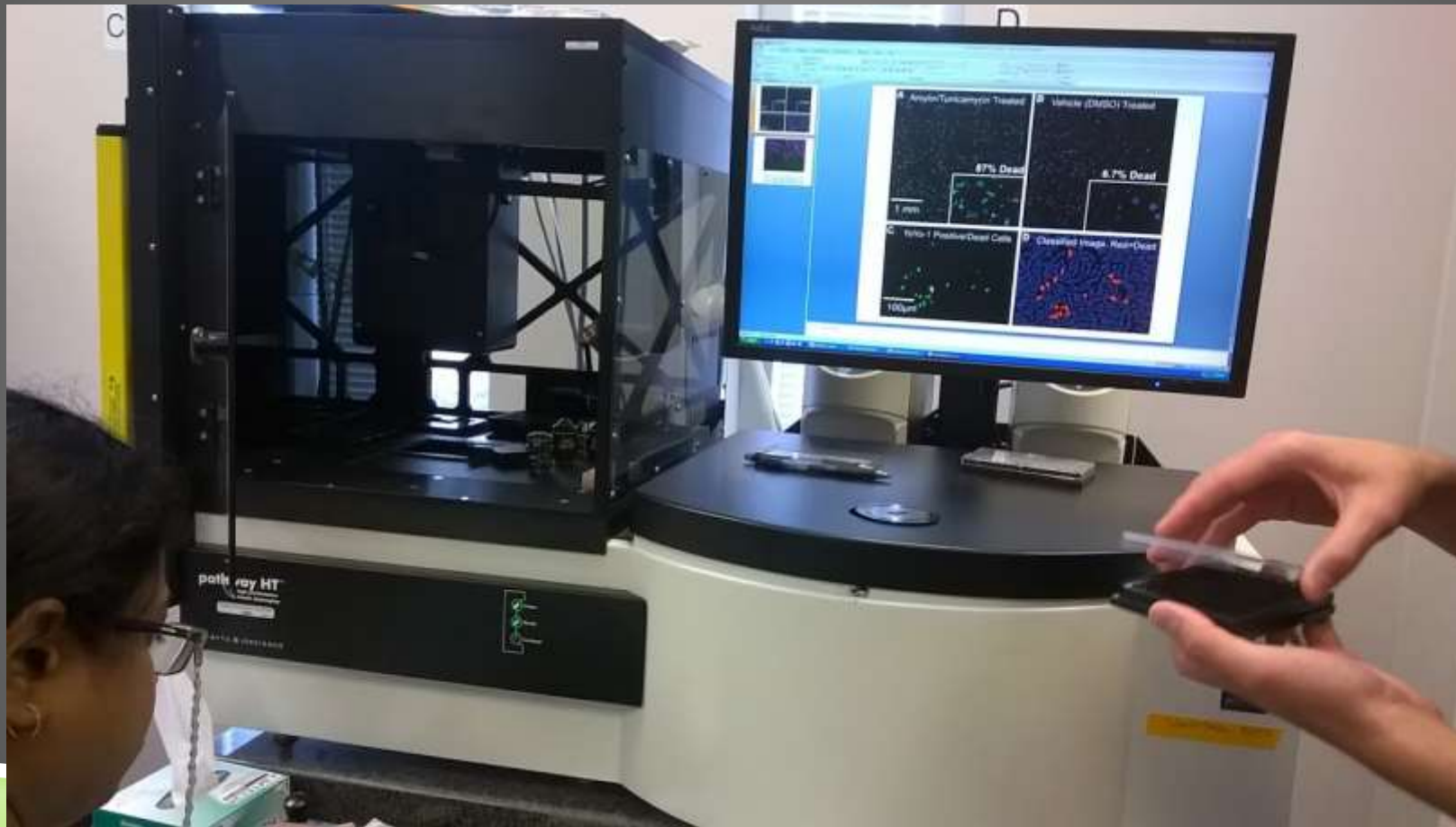
[/http://www.ncbi.nlm.nih.gov/books/NBK6177](http://www.ncbi.nlm.nih.gov/books/NBK6177)

LYSOSOMAL DISEASES –B.R.I.T.E

- ▶ Utilizes Basic fluorescence microscopy to “tag” organelles for view
- ▶ High Performance Kinetic Bioimaging-High Content Imaging Process
 - ▶ Identify specific organelles and how they are affected by chemicals, specifically possible drugs for treatment
 - ▶ Speeds up identification of drug that will affect the desired target organelle
 - ▶ Requires screening with high throughput techniques-testing many different drug candidates at one time



B.R.I.T.E- HIGH PERFORMANCE KINETIC BIOIMAGING MACHINE



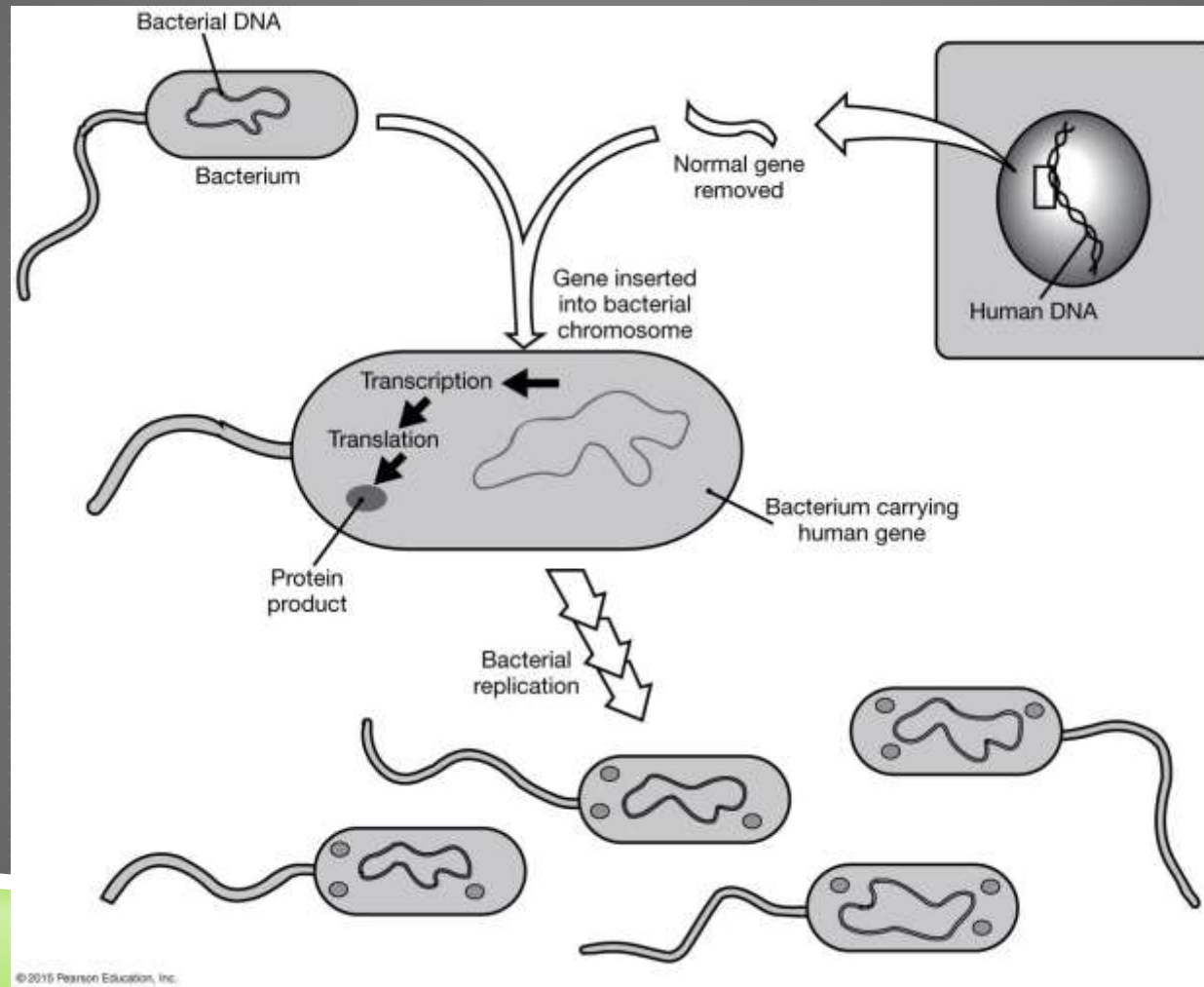
METABOLISM FOR GROWTH AND MEMBRANE RECEPTORS OF CELLS -WFIRM

- ▶ Insulin is a protein which binds to membrane receptors to allow glucose to be moved into the cells.
- ▶ Glucose is the primary component of cellular metabolism, and is broken down to produce energy for the cell to function.
- ▶ Type I diabetics do not have functional beta cells to produce insulin and must take insulin to be able to metabolize glucose and produce cellular energy.

METABOLISM FOR GROWTH AND MEMBRANE RECEPTORS OF CELLS -WFIRM

- ▶ Artificial pancreas cells are produced by encapsulation.
- ▶ In addition, membrane receptor proteins must be degraded from the surface of the artificial pancreas cells so that the body does not see them as foreign and reject/ attack them.
- ▶ This therapy is meant to be a “Bioartificial pancreas”, giving Type I diabetics the option to gain cells that produce insulin, since they have lost those cells and that function.

PROTEIN SYNTHESIS AND SECRETION FERMENTATION



PROTEIN SYNTHESIS AND SECRETION FERMENTATION/BIOREACTION-BIOGEN

- ▶ Recombinant DNA engineering to produce a desired product
- ▶ Can be done within eukaryotic or prokaryotic cells
- ▶ Specifically, fermentation is usually using prokaryotic cells with a plasmid that has been engineered to produce your desired chemical/enzyme/protein and occurs in fermenters. Product often accumulates in the inclusion bodies.
- ▶ Product may be secreted from the cell and isolated from media or the inclusion bodies /protein reservoirs may be isolated from the cell and used.

SMALL FERMENTER -RCCC

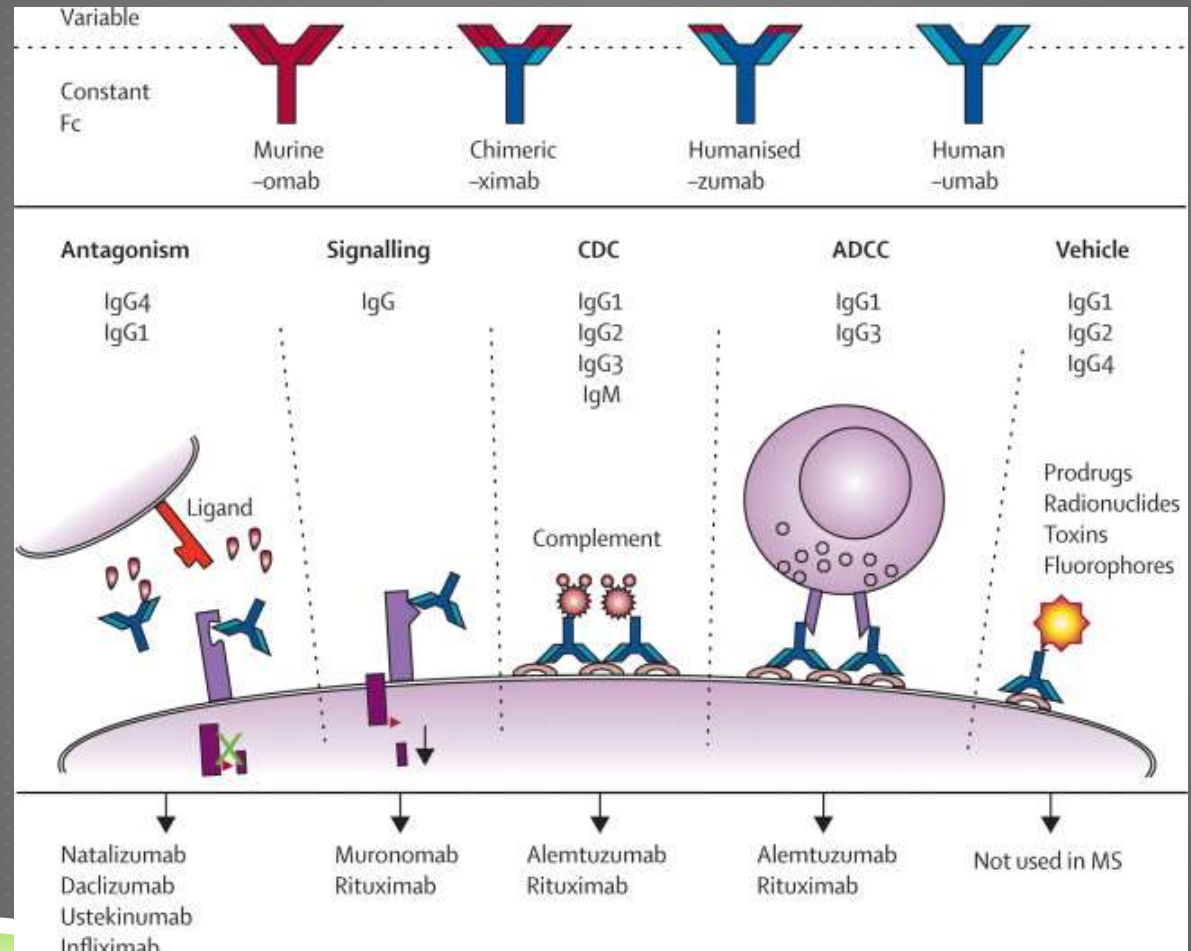


LARGE SCALE BIOREACTOR

PROTEIN SYNTHESIS AND SECRETION FERMENTATION/BIOREACTION-BIOGEN

- ▶ In eukaryotes, it is usually termed “bioreaction” and occurs in bioreactors.
- ▶ In eukaryotes, it will also need to be isolated from the cell or the media where the cells are grown and purified.
- ▶ Products may include items such as monoclonal antibodies for targeted drug treatments.

ACTIONS OF MS DRUGS-MONOCLONAL ANTIBODIES



https://lookfordiagnosis.com/mesh_info.php?term=antibody%20specificity&lang=1

Lancet.com

ACKNOWLEDGEMENTS

- ▶ BIFP and all sites visited
- ▶ NSF-ATE
- ▶ Dr. Russ Read





References and Credits

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- ▶ http://www.nasa.gov/sites/default/files/missions_using_blackjack_receivers.png
- ▶ Kristina Burgess, Ph.D
- ▶ http://www.nasa.gov/sites/default/files/missions_using_blackjack_receivers.png
- ▶ BTEC

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Poll the audience for Students, Educators and
Life-long Learners

**Why should we
listen?**

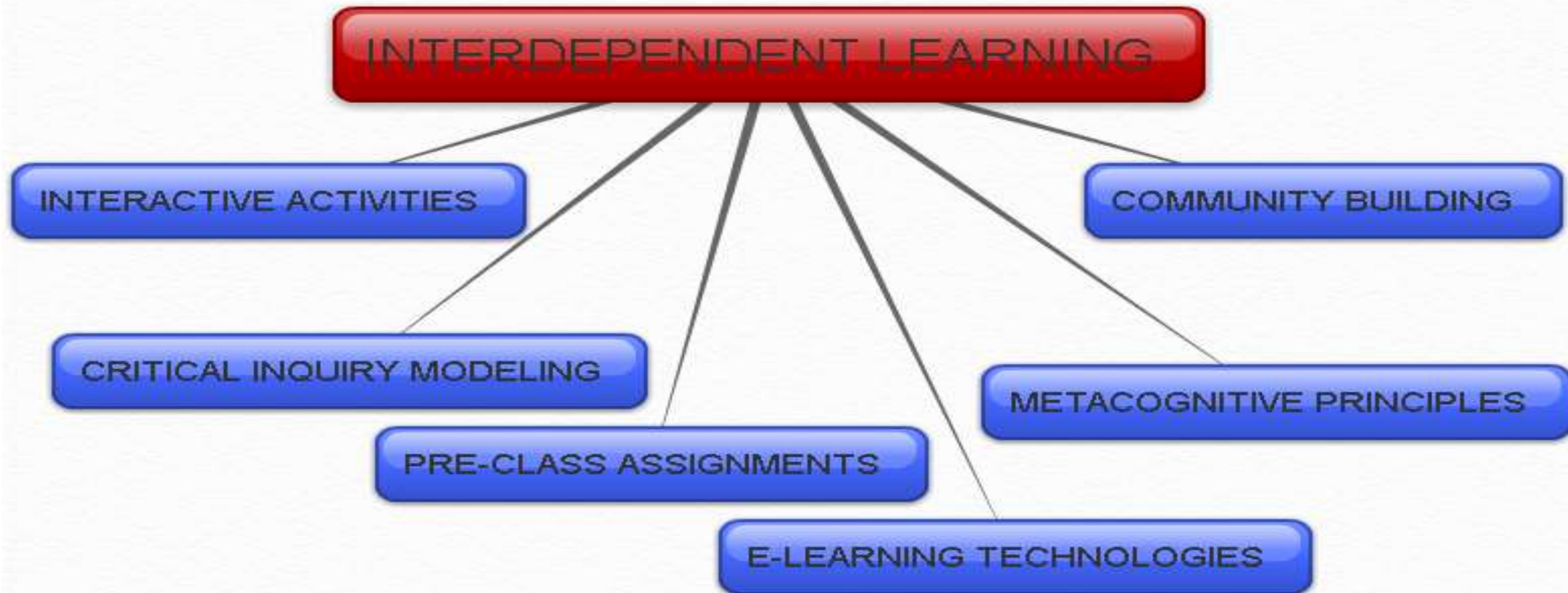
Using Instructional Design to Contextualize Advancements in Biotechnology through Collaboration Focusing on Anatomy and Physiology Classes

Presented by Tandeka Boko, MD and
Caroline Smith, MAT
Forsyth Technical Community College

A 2016 Bioscience Industry Fellowship Project

Funded by National Science Foundation (NSF) Advanced Technological Education (ATE) Grant #1304010

Heutagogy (Kenyon & Hase, 2001)



Instructional Event: THE HOOK

- **Cognitive research on effective learning by Gagne' and Briggs**
- **Activity, Image, Question, Quote or Technology-based Tool that gains the learner's attention**
- **Focuses learners on the lesson topics of the day**

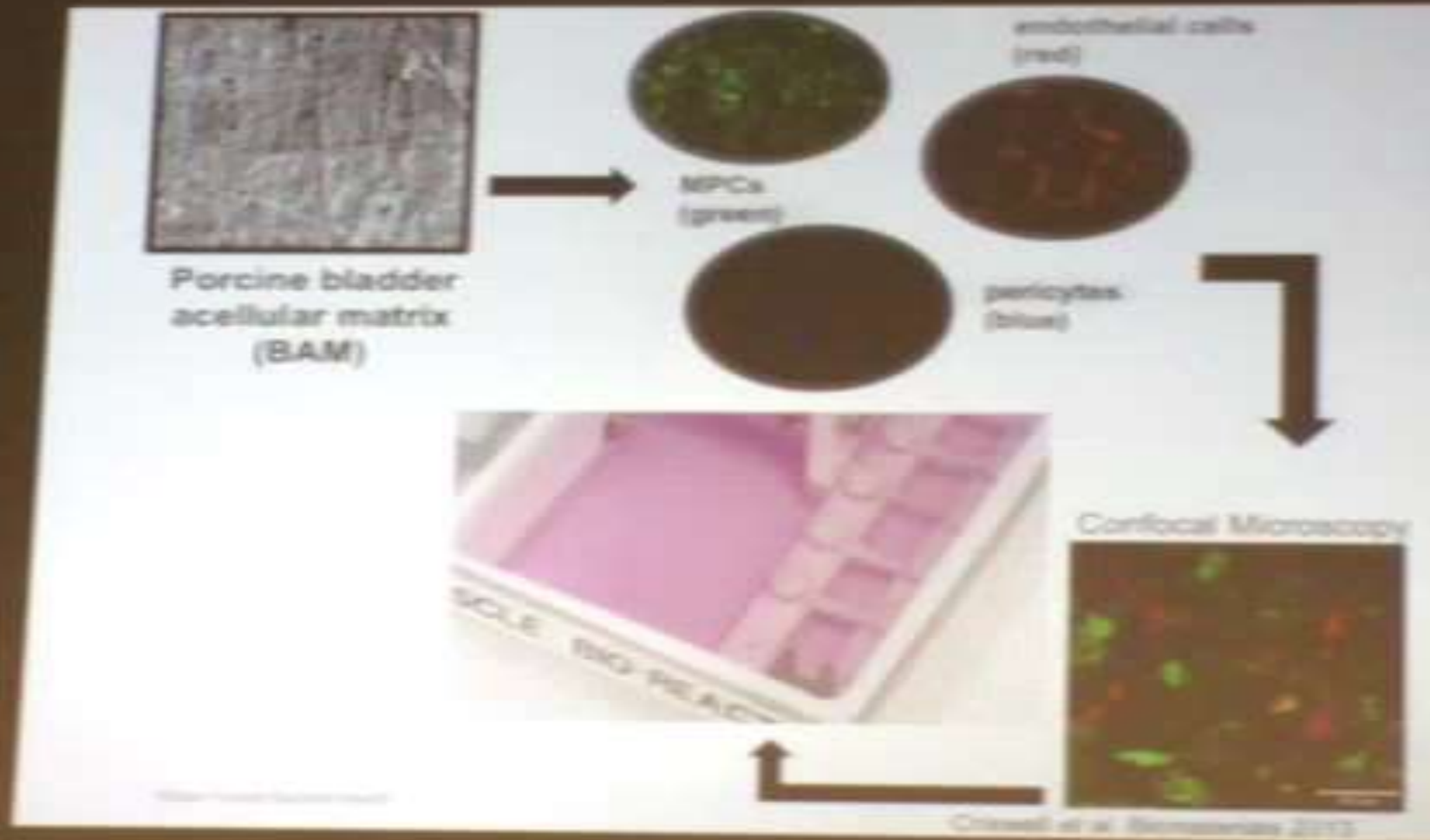


Can we make a nanoparticle that chases down cancer cells & kills them?

(Joint School of Nanotechnology and Nanoengineering; Video courtesy of David Rogers)



Compare & contrast the action potential of this skeletal muscle to cardiac muscle action potential.
(Skeletal Muscle Engineering WFIRM)



Face	Cranium	Associated Bones
Maxillae	Occipital bone	Hyoid bone
Palatine bones	Parietal bone	Auditory ossicles enclosed in temporal bones*
Nasal bones	Frontal bone	
Inferior nasal conchae	Temporal bones*	
Zygomatic bones	Sphenoid	
Lacrimal bones	Ethmoid	
Vomer		
Mandible		

Table 1. Skull and Associated Bones

Practice labeling a random selection of skull and/or associated bones below.



[return to top](#) | [previous page](#) | [next page](#)

Labeling Activity - Mozilla Firefox
Close

<https://blackboard.forsythtech.edu/bbcswebdav/pid-2371316-dt-conter>

Labeling Activity

Drag the labels from the bottom to the correct slots.

Score 11.4/16
Re-start

Center for Design Innovation

Pamela Jennings, PhD
Executive Director



Founding and
Funding Partners



Center for Design Innovation awarded HoloLens developer kits from Microsoft, to add hologram augmented reality to its line of research

Photo: [Microsoft HoloLens](#)



Microsoft HoloLens

Winston-Salem, NC – November 12, 2015 – The Center for Design Innovation, a multi-campus research center of the University of North Carolina system, is a finalist in the [Microsoft HoloLens for Academic Research](#) program and will receive two HoloLens

developer kits and specialized training at the Microsoft campus in Redmond, WA. This award will enable CDI to advance its research by augmenting design processes with interactive holograms. The award will introduce cutting edge technology to faculty and students from CDI's academic partners including Winston-Salem State University, UNC School of the Arts and Forsyth Technical Community College.

Microsoft HoloLens

Michael Batalia, PhD

Co-Founder of
WideEy3d 3D Printing Solutions



HUMAN ANALOGUE APPLICATIONS™

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Moulage: (French: casting/moulding)
The art of realistic injury simulation for EMS Training, Tactical Medicine Training, Department of Homeland Security Training scenarios, law enforcement.

[Moulage Spec Sheet](#)[Customization Options](#)[How to Order, Contact Us](#)

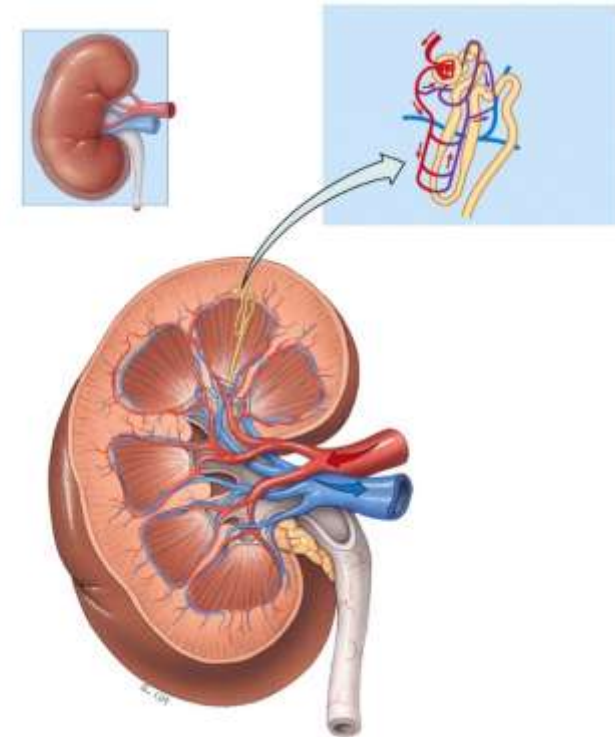
Human Analogue Applications provides custom Moulage solutions catered to your individual needs. From small scale (1 to 10) individual injuries to mass casualty with upwards of 100 individual injuries.

Concept of a Million Nephrons in the Kidney

Decellularized Kidney (WFIRM)



Traditional Textbook Nephron (Wiley)



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Medical Artifacts: Local doctor has a story to tell for each item in his extensive collection of old instruments

Story Comments

Print Font Size

Recommend Tweet G+1 Pin it Share

Posted: Monday, August 17, 2009 2:09 am

Mary Giunca

Dr. Jack Monroe held up an elaborate porcelain blue and white bowl with a half circle sliced from the rim and in the calmest of Marcus Welby voices explained how the sliced-out portion of the bowl fit under the patient's neck or elbow as a vein was slit and the patient's blood was collected in the bowl.

"Bleeding bowls are beautiful bowls, I think," he said.



Dr. John Monroe, a retired obstetrician-gynecologist, demonstrates the uses of his antique medical instruments as he walks through his home.



WFIRM



Regenerative Medicine Essentials

The image is a screenshot of the Wake Forest School of Medicine website. At the top left is the Wake Forest School of Medicine logo. To the right is a search bar with a dropdown menu and a search button. Below the logo and search bar is a navigation menu with tabs for Patients & Visitors, Referring Physicians, Research, Education, and About Us. A secondary navigation bar contains links for Innovation, Undergraduate & Postdoc, Departments, Clinical Trials, Institutes & Centers, Shared Resources & Core, Faculty, and ITM. The main content area features a section for the Wake Forest Institute for Regenerative Medicine. On the left is a sidebar with links: Checkouts for Regenerative Medicine, Our Story, The WICs of Organ Engineering, Our Research Projects, Our People, Education Programs, Partnerships and Outreach, and News & Updates. The main content area has a header for the Institute, a large image of a scientist in a lab coat, and text describing education and training programs. Two upcoming programs are listed: a Regenerative Medicine Leadership Course (Aug 11-15, 2014) and a Regenerative Medicine Conference (Oct 29-31, 2014). A footer bar contains a link to learn more about upcoming programs and a set of five navigation dots.

Wake Forest School of Medicine

Search [dropdown] Search

Patients & Visitors | Referring Physicians | Research | Education | About Us

Innovation | Undergraduate & Postdoc | Departments | Clinical Trials | Institutes & Centers | Shared Resources & Core | Faculty | ITM

Checkouts for Regenerative Medicine

Our Story

The WICs of Organ Engineering

Our Research Projects

Our People

Education Programs

Partnerships and Outreach

News & Updates

Wake Forest Institute for Regenerative Medicine

Discover the education and training programs the Institute offers.

Regenerative Medicine Leadership Course
Aug. 11-15, 2014 | Winston-Salem, NC
Registration Now Open

Regenerative Medicine Conference
Oct. 29-31, 2014 | Winston-Salem, NC
www.registration2014.org
Registration Coming Soon

Learn More About Upcoming Program Dates and Deadlines

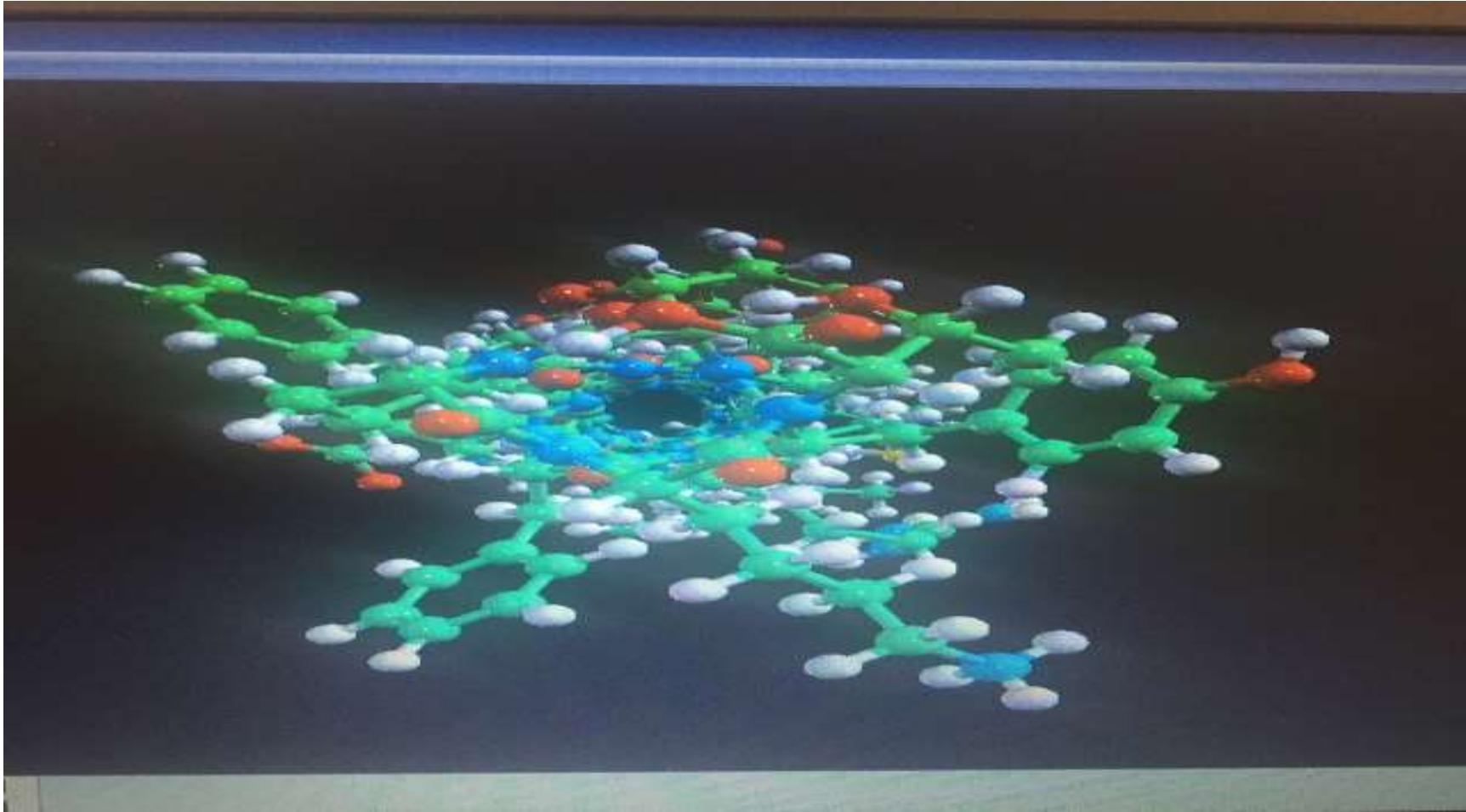
Polymerase Chain Reaction Article

- Suppose you pick up a journal and read an article on using polymerase chain reactions (PCR) and gel electrophoresis to predict one's bitter tasting ability.
- If the PCR product made from the gene coding for the bitter taste receptor is assigned (T) for the taster allele and (t) for the non-taster allele,
- **What is the likely genotype of the person in the next slide?**

What Is Her Most Likely Genotype? (Heredity Lab on Inheritance)



What two basic properties of positive and negative charges did the developer of this model use, in order to give this insulin molecule stability in its 3D conformation (Aspart Insulin)?



Hint #1: Anion Exchange Chromatography Columns

ANIONIC CHROMATOGRAPHY

FLOW OF SOLUTION

BINDING OF NEGATIVELY CHARGED AMINO ACIDS TO CATION SURFACE OF COLUMN

ANIONS IN SALT COMPETE OFF BOUND ANIONS ON CATION SURFACE OF COLUMN

33% ELUTION

HIGHER concentration of salt needed to bounce off strongly bound anions off of cation surface (HIGHER CONCENTRATION OF ELUTION BUFFER)

* Please do not use alcohol on this board *

Hint #2: Using Biosensor Technology to Personalize Medical Care (BRITE)

Select font size T T T

What properties of positive and negative charges did the researchers utilizing these technologies use to their advantage?



Select font

Insert

Allow Single Choice Only Allow Multiple Choices Shuffle Answers Allow Retry Limit Attempts

Allow !

Insert

A. Positive and negative charges are both created and destroyed.



Sorry, positive and negative charges occur in discrete units and are neither created nor destroyed.



Insert

B. There are three (3) types of electrical charges.



Try again because there are only two types of electrical charges: positive and negative.



Preview

Preview

[Terms](#) | [Privacy & Cookies](#)

[Terms](#) | [Privacy & Cookies](#)

Why learn about positive and negative charges?

Fruit Fly Foot (Joint School of Nanoscience and Nanoengineering)



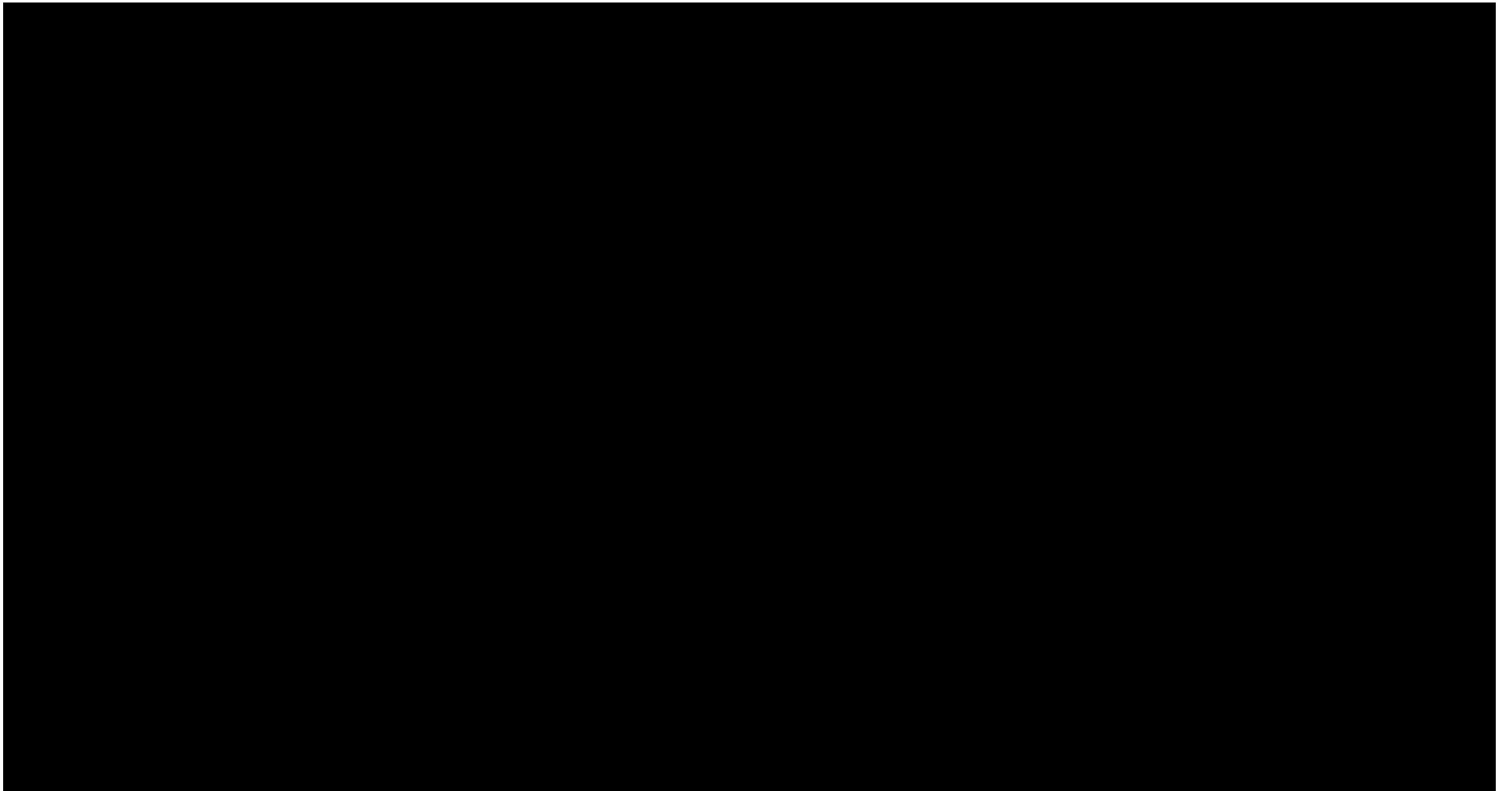
Geico Hairs on Foot (Joint School of Nanoscience and Nanoengineering)



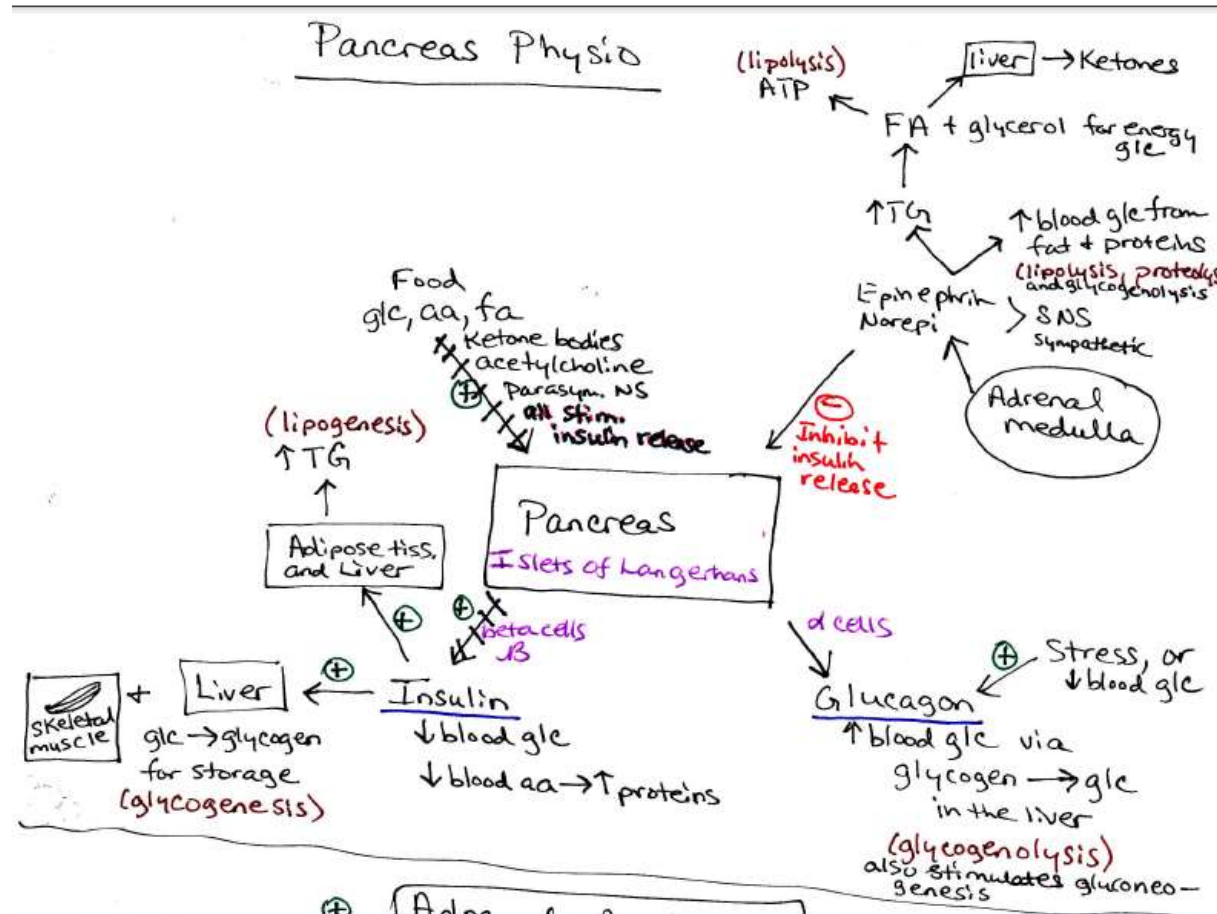
Guiding Questions for Novozymes Video

- **Why do we have to work together?**
- **Why do I have to teach myself and others?**
- **Why do I have to write reflections before each test?**

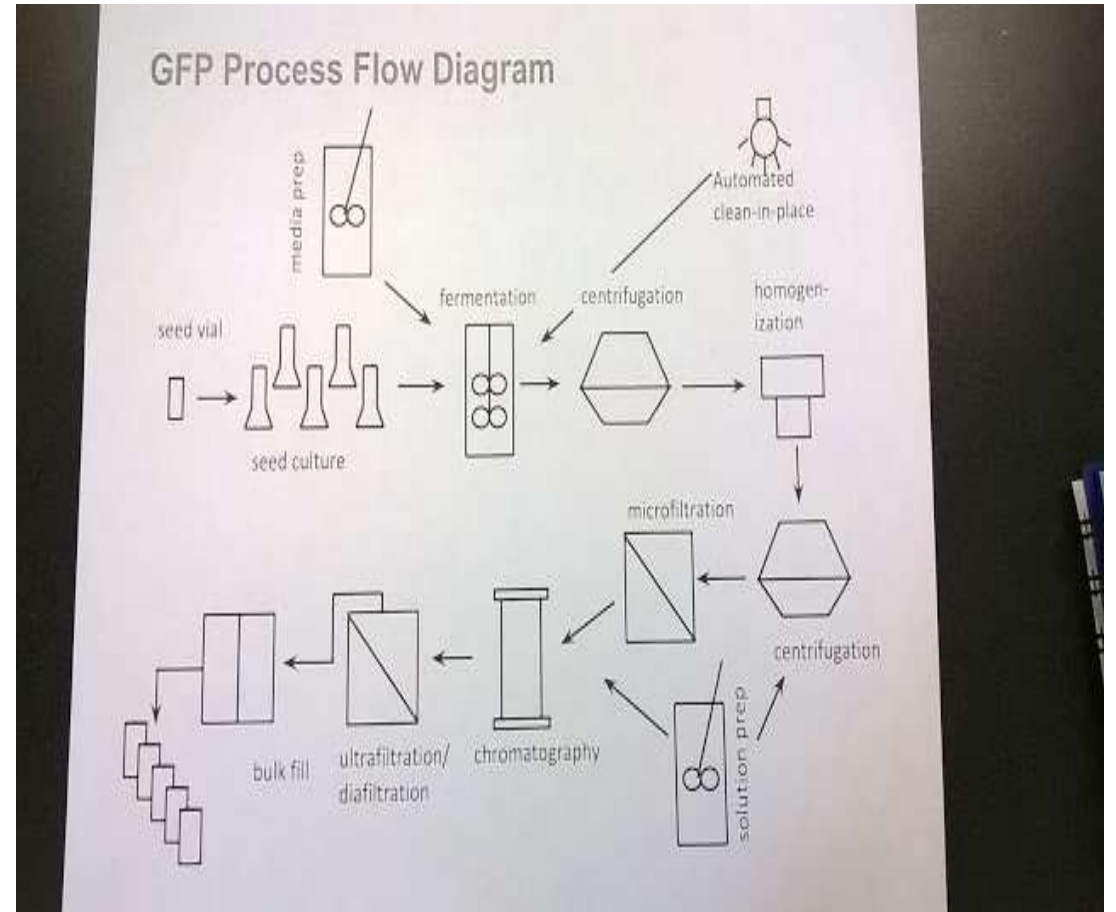
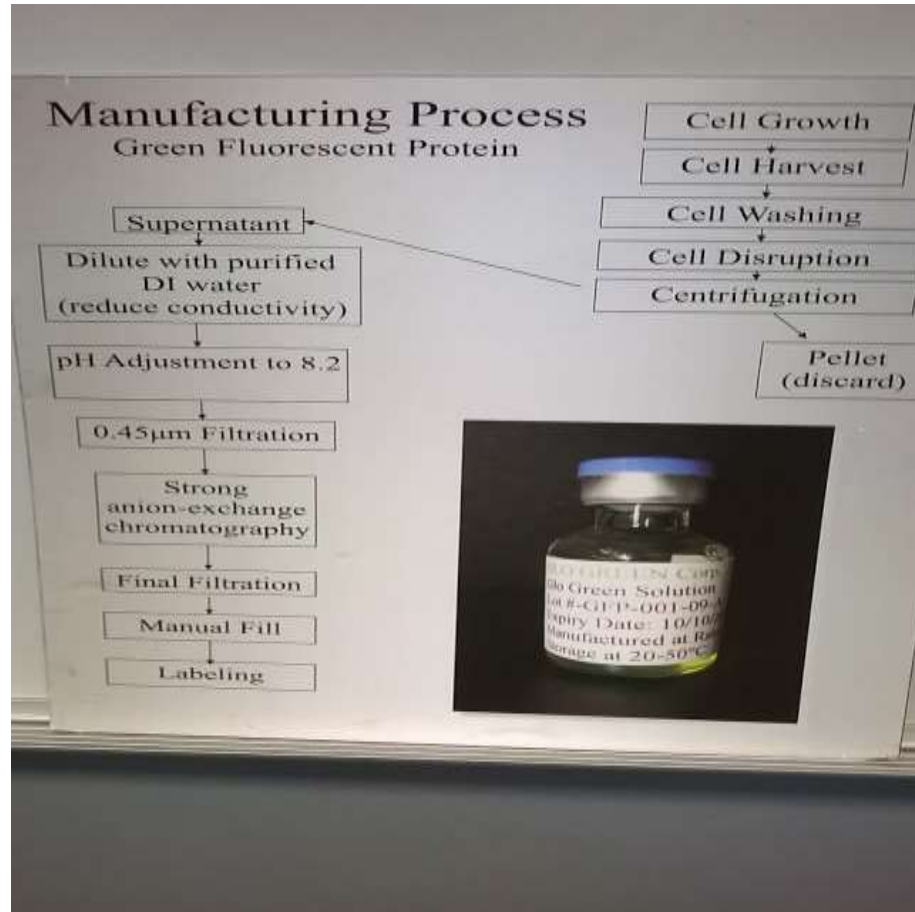
Try activities that may guide them to discovering these answers on their own. For ex, before a video, I may ask, “What aspects of this video made you curious?” Or, if the video is shown at the end of the first quarter of class, “What aspects of this video have been demonstrated to date? Can you see yourself utilizing any other themes later on in class? How does what you heard or saw relate to our learning environment?”



Why do I have to make, read and predict from mind maps (concept maps, flow diagrams)?



Because it can help to not only perform a job, but to also effectively troubleshoot problems.



Why Memorize So Much?

Memorizing a strong foundation of details and facts in Anatomy and Physiology opens the doors to allow you the opportunity to walk into not only direct health care industry related career pathways, but also pathways into the bioscience industry.

Hemophilia Therapies



HEMOPHILIA

Biogen

Advice from a Forsyth Tech Alumna



I've learned that people
will forget what you
said, people will forget
what you did, but
people will never forget
how you made them
feel.

Maya Angelou



Bioscience Industries Fellowship Program June 1 – 24, 2016
NSF Grant # 1304010

Anuradha David, Ph D
Associate Professor
Department of Zoology
Kittel Science College
Dharwad, INDIA
dmanuradha@gmail.com

BIFP - OBSERVATIONS

- * Encompasses novel advances in “Bio” Science
- * Laid the premise for skill development in students with appropriate applications – Tools and Techniques
- * The program was a step aside from “classical biology”
- * Potential for Bridging disciplines
- * Well planned Boot camps

Novel Advances in “Bio” Science

REGENERATIVE MEDICINE

- Involves the replacing, engineering or regenerating human cells, tissues or organs to restore or establish normal function.
- Helps to improve patient developing regenerative medicine therapies support technologies such as use of biomaterials/scaffolds
- Tissue engineering and regenerative medicine helps guide/boost the body’s own natural ability to heal itself
- **RP: J Schanck, Wake Forest Institute for Regenerative Medicine**

BIOPHARMACEUTICALS AND MANUFACTURING

- Bio-Pharma industry discovers, develops, produces and markets drugs and devices approved for human use.
- High Point Clinical Trials Center – HPCTC. These trials are conducted in domiciled patients.
- **Intellectual Property** - Protection of inventions and trade marks. Novel drugs are inventions. Patent grants the grantee the right to prohibit others from practicing the invention.
- **RP: Dr. Robert Andrews, VTV Therapeutics Transtech Pharma. Dr. Michael Batalia, Intellectual Property Rights**



MEDICAL CHEMISTRY

Invention, discovery, design, identification and preparation of biologically active compounds, the study of their metabolism, the interpretation of their mode of action at the molecular level and the construction of structure-activity relationships. GANT – 61, Hedgehog genes

- **RP: Mr. Chris Laudeman, Bio-manufacturing Research Institute and Technology Enterprise (BRITE), NCCU**



GENOME THERAPY (GT) AND GENE EDITING

- Replacement of a faulty gene or addition of a new gene to cure disease or improve then body's ability to fight disease. DNA is inserted, deleted or replaced in the **genome** of an organism using engineered nucleases, or "molecular scissors."
- **Three strategies for somatic cell GT : Ex vivo, In situ, In vivo**
- **Example of ex vivo somatic cell GT – Eg. Hematopoietic stem cells.** Target cells from the patient are infected with recombinant virus containing the desired therapeutic gene. These modified cells are re-introduced into the body where they produce the desired proteins encoded by the therapeutic DNA
- **Example of in situ somatic cell GT** - Infusion of **adenoviral vectors** into the trachea and bronchi of cystic fibrosis patients. Injection of a **tumor mass** with a vector carrying the gene for a cytokine or toxin.
- **Example of in vivo somatic cell GT** – Involves introduction of therapeutic DNA directly into the body. Injection of liver tropic adeno-associated virus (AAV) to treat hemophilia B.
- **RP: Dr. Christopher Porada, Wake field Institute for Regenerative Medicine**

Tools and Techniques

NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY

- Chemical elucidation, Protein structure, Metabolomics, Ligand binding

RP: Dr. Kevin Knagge, NMR Facility at the North Carolina Research Campus. David H Murdoch Research Institute.





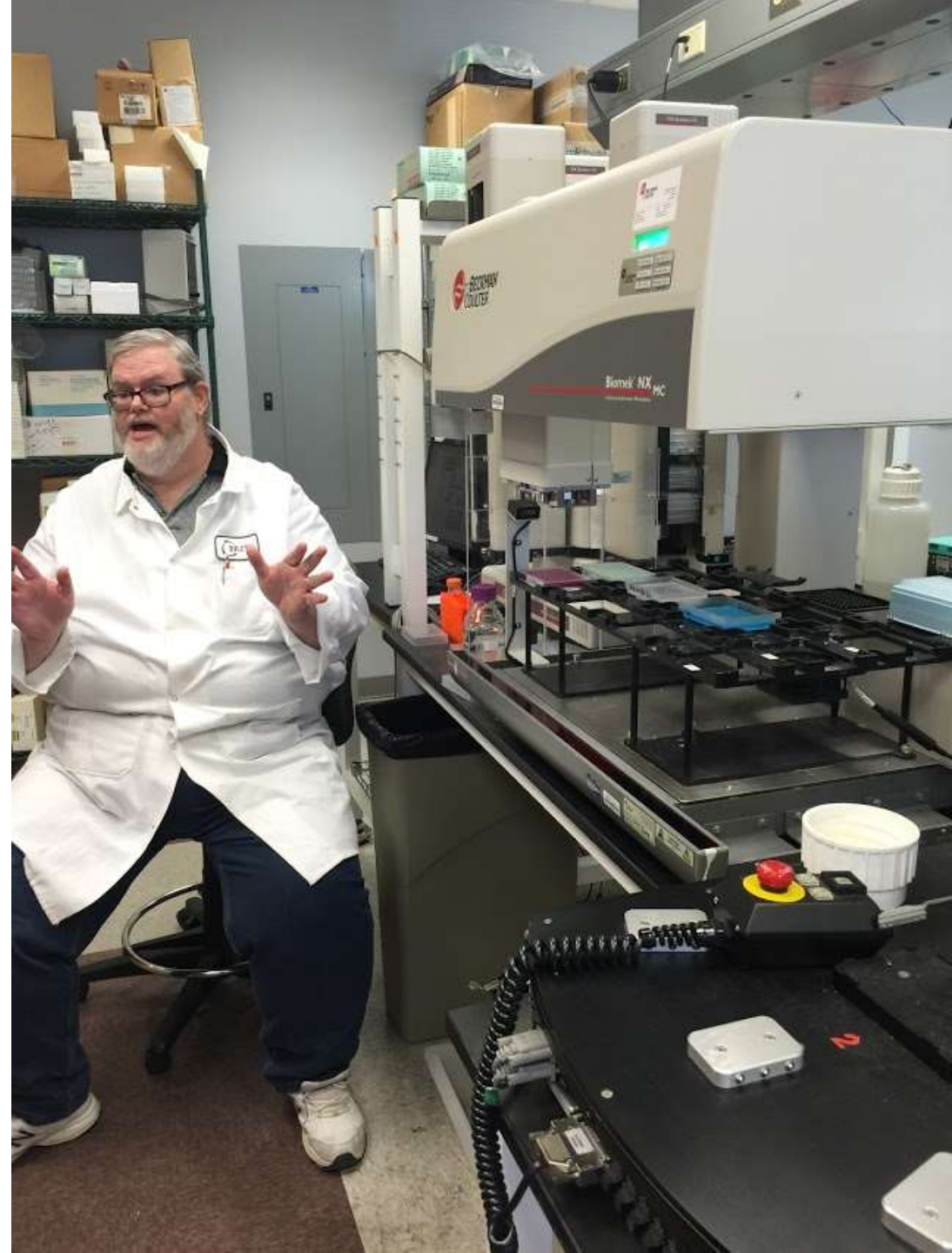
CELLULAR IMPEDANCE ASSAY

- Use of Biosensors in screening medications used to treat prostate cancer cells. To develop a chemo-screen from among the medications - individual and in combination – for the best results in chemotherapy treatment of cancer in different stages.
- **RP: Ms. Audrey Adcock, Bio-manufacturing Research Institute and Technology Enterprise (BRITE), NCCU**

DIGITAL AUTOMATION

- Digital automation for high throughput screening using Biomechanics and Robotics. Sickle cells used as case study.
- Technique is used in colorimetric assay, time resolved radioactive assay, luminescence assay. Automation in digital dispensation ensures analysis of samples in as small quantities as pico liters.
- **Mr. Brent Caligan, Bio-manufacturing Research Institute and Technology Enterprise (BRITE), NCCU**

DIGITAL AUTOMATION
Mr. Brent Caligan, Bio-
manufacturing Research
Institute and Technology
Enterprise (BRITE), NCCU



HIGH CONTENT IMAGING

- Automated microscopes capture events in each cell placed for observation in a 96 well plate. Cancer and Beta cells of the pancreas are used as candidates.
- Images provides large amounts of comprehensive data in terms of phenotype changes in cell morphology, cellular count (quantification), apoptotic cells and membrane status.
- Image J is the software used for imaging. Up to 29 images are recorded per cell in a 96 well plate. About 10 – 20000 compounds can be analyzed in a week's time.
- **RP: Mr. Rob Onyenwoke, Bio-manufacturing Research Institute and Technology Enterprise (BRITE), NCCU**

HIGH CONTENT IMAGING RP: Mr. Rob Onyenwoke, Bio-manufacturing Research Institute and Technology Enterprise (BRITE), NCCU



BIOMATERIALS AND TISSUE ENGINEERING

- Traditional drug screening models. 1. Animal models 2. Traditional 2D cell cultures. Both approaches have yielded significant advances in medical research and development of drugs, process of tissue engineering, development of scaffolds.
- The ultimate goal is to replace damaged and non-functioning tissues or organs.

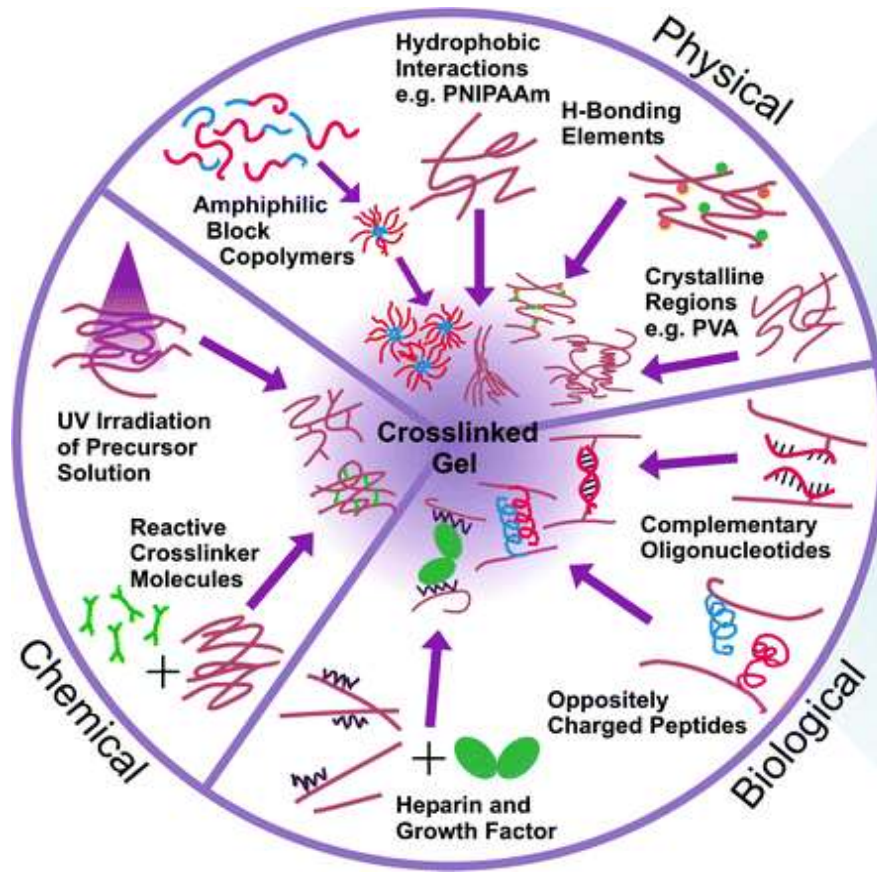
**RP: Dr. Aleksander Skardal, Dr. Tracy Criswell,
Wake Forest School Of Medicine, Institute of
Regenerative Medicine**

Biomaterials-Scaffolds

➤ **Scaffold** provides structure for cells/tissue to grow and deliver biomolecules (growth factors, cytokines, etc.)

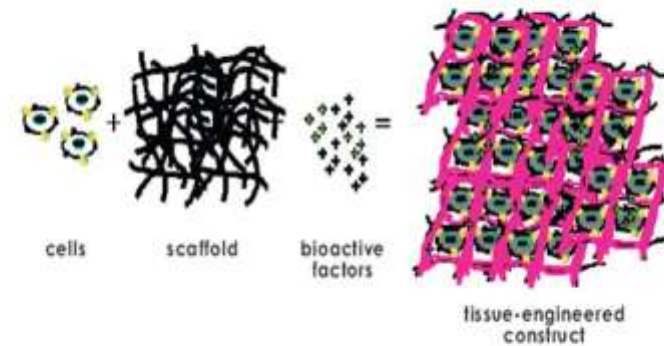


➤ Properties (chemical, mechanical, biological) should be adjusted to provide appropriate performance.



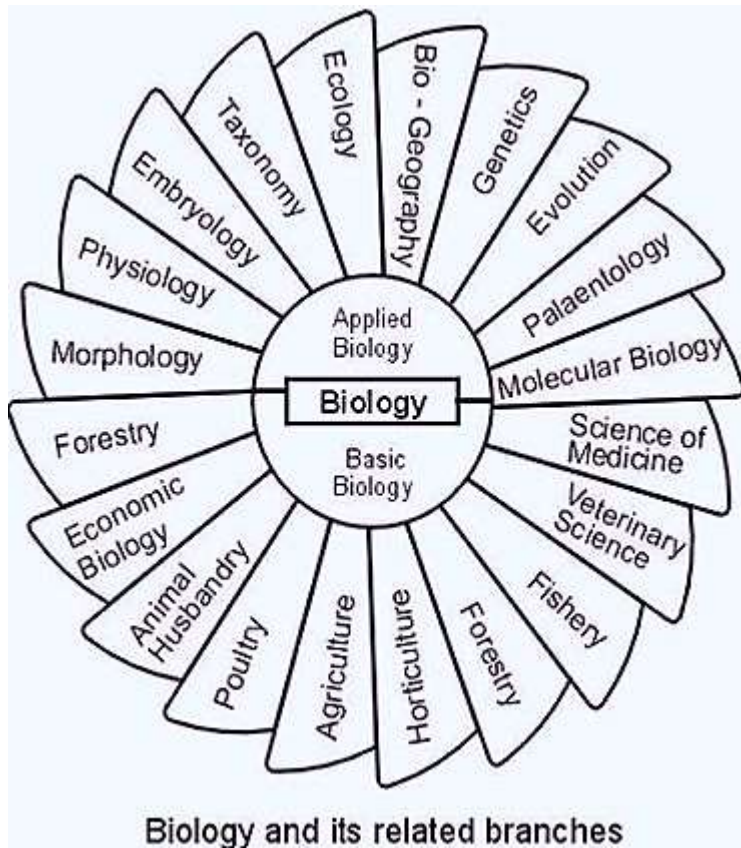
Tissue Engineering Scaffolds

- Scaffold – an artificial structure capable of supporting 3 dimensional tissue formation (e.g. Collagen and some polyesters)

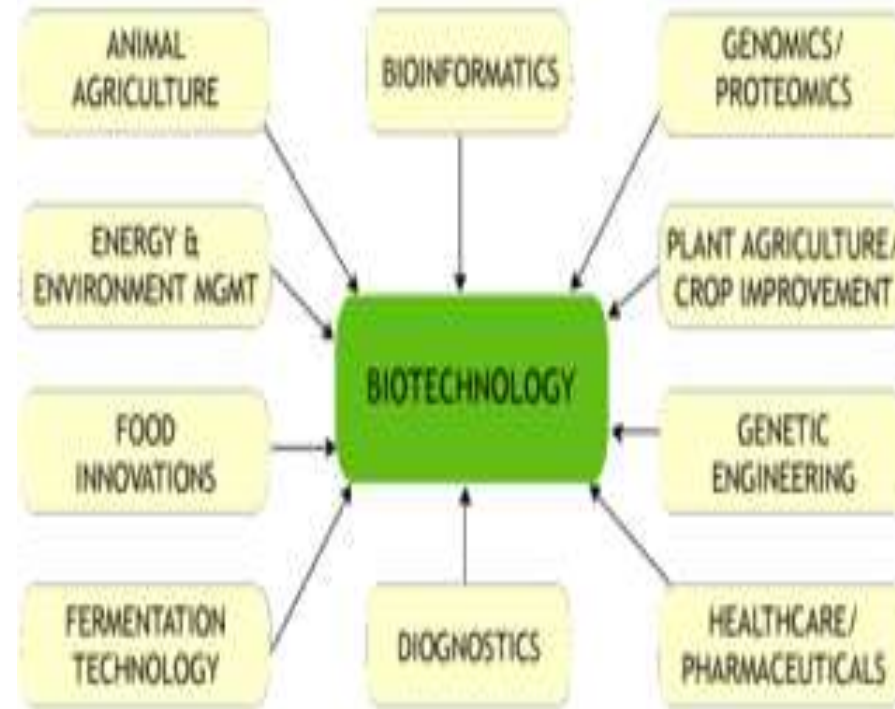


Bio materials – Wake Field Institute for Regenerative Medicine





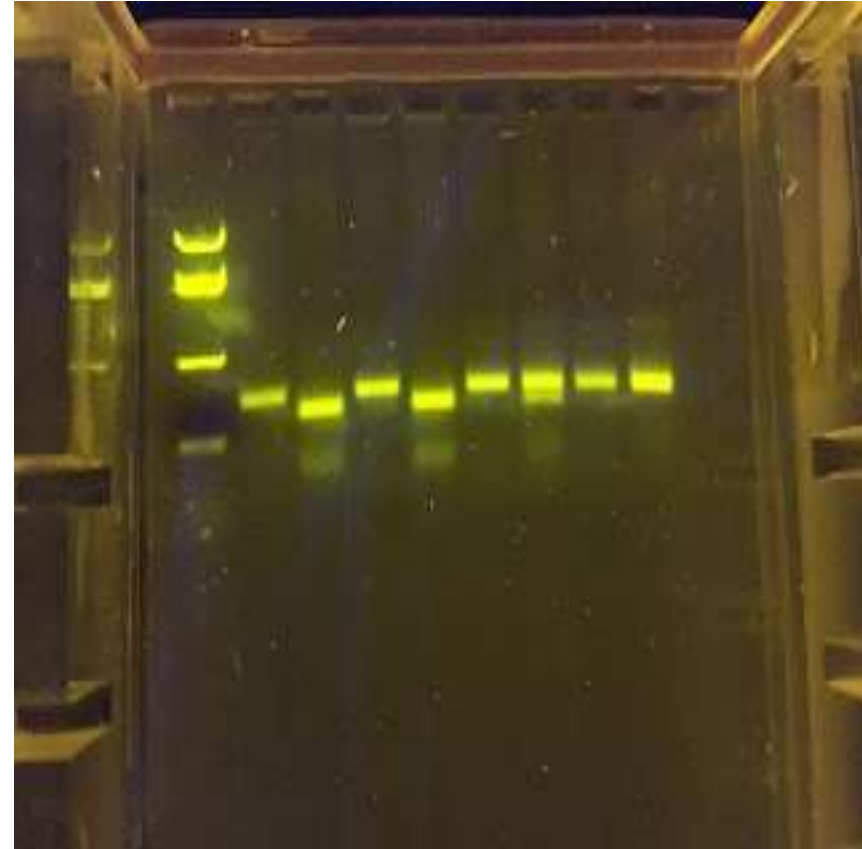
Step aside from “classical biology”



Regenerative Medicine
Gene Therapy
Medical Chemistry
Biopharmaceuticals

Bridging disciplines

- New method in pedagogy
- Use of PCR to determine the genotype of tasters and non-tasters to PTC
- Understanding the Mendelian principles of inheritance
- *Handout 1



Profiling Indian Chillies – Using GC-MS

- *How pungent are Indian Chillies on the Scoville scale?
- *Handout 2

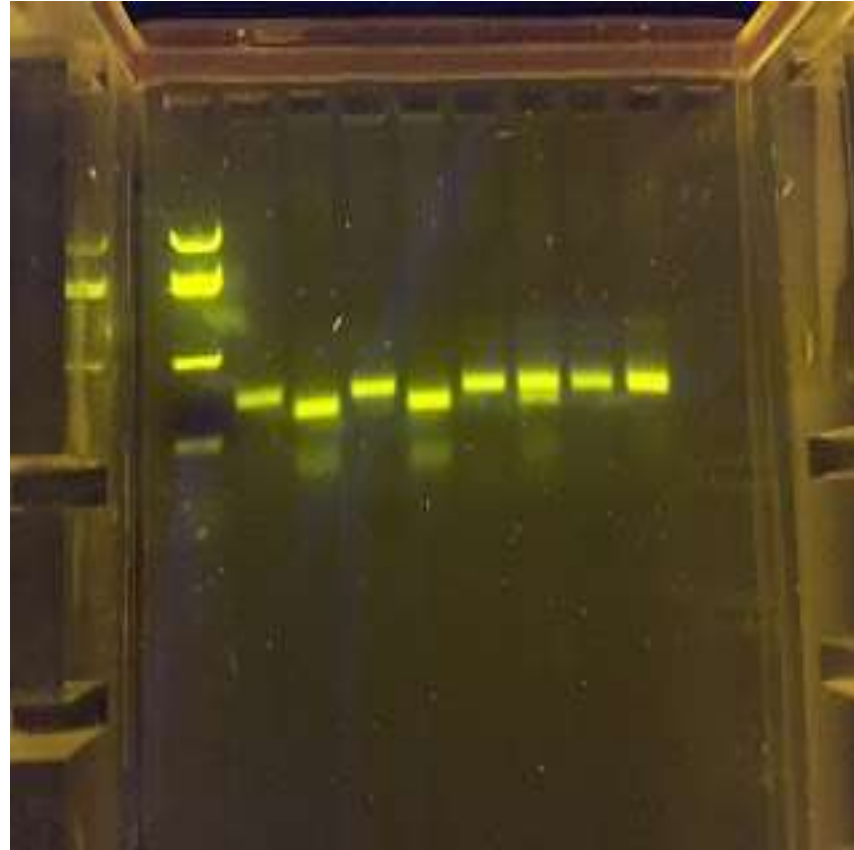


BOOT CAMPS

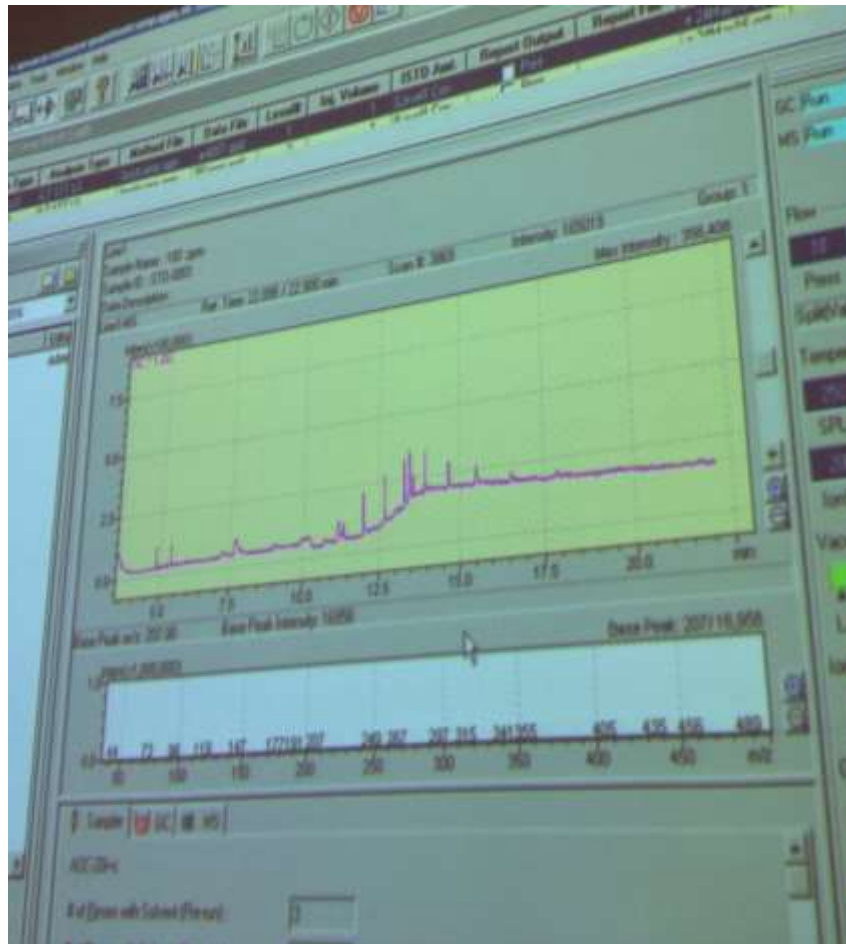
Boot camp 1 – PCR determination of SNP related to bitter taste receptors



RP: Dr. Alan Beard, Forsyth Tech Community College



Boot camp 2 – Identification and Quantification of Capsaicin compounds in selected peppers



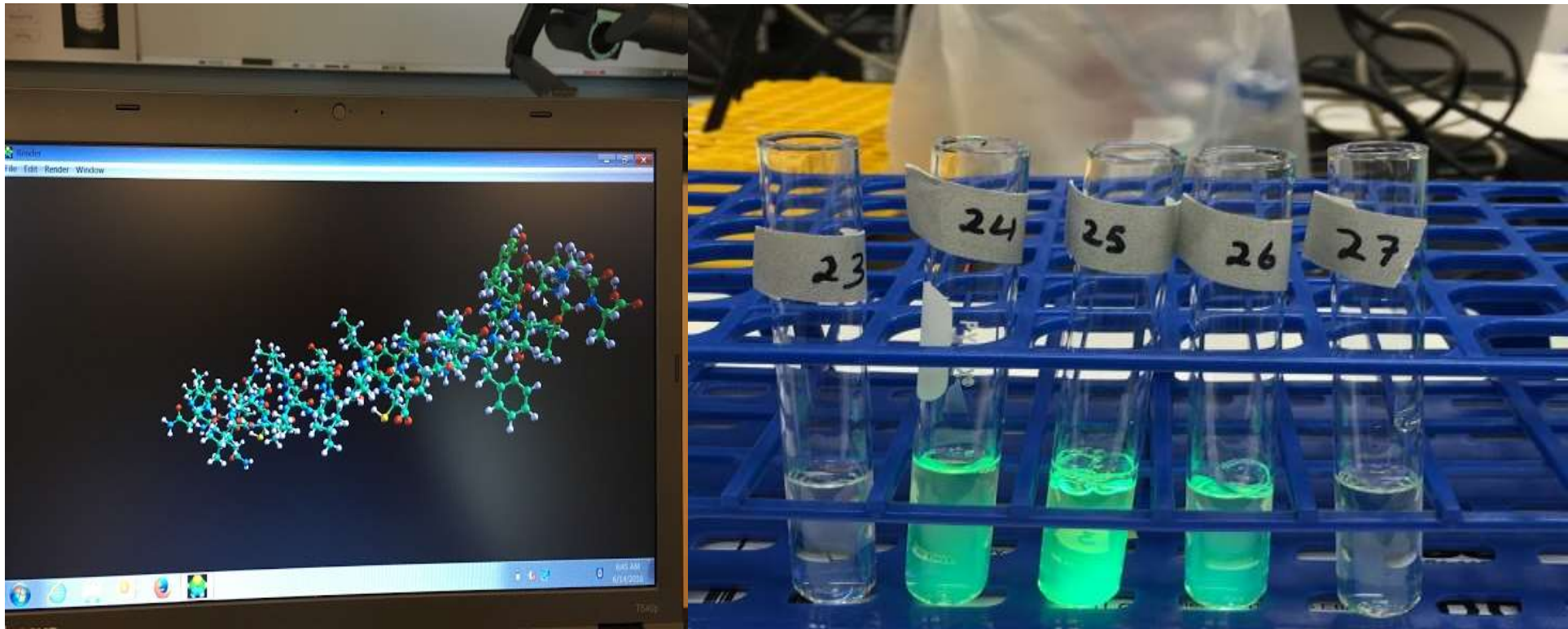


**RP: Dr. Denise Schweizer, Rowan
Cabarrus Community College**



Boot camp 3 – BioNetwork Capstone Learning Center, North Carolina State University

- Building a virtual protein (B chain of human insulin), Virtual Protein Lab
- Upstream and Downstream processing of Green Florescent Protein (GFP)



**RP: Dr. Kristina Burgess,
BioNetwork Capstone
Learning Center, North
Carolina State University**



Boot Camp 4 Alamance Community College, Graham

- Use of M Air T Millipore Tester to conduct airborne microbial testing
- Split sub-culturing of CHO-K1 Cell Line into a T-25 flask
- Tangential Flow Filtration (TFF) to purify and concentrate a molecular entity from a mixture

**RP: Dr. Bill Woodruff,
Alamance Community
College, Graham**



Conclusions - Integrating Bioscience as a discipline

- Development of draft curriculum for Biosciences
- Steer students towards careers in the bioscience workforce
- Guest lecturers from industry
- Tours of bio-manufacturing facilities
- Learn networking, access to pertinent websites
- Internships that strengthen skill development that prepare students for employment

Grateful Acknowledgements

- Dr. Russ Read, Principal Investigator, BIFP and Executive Director, National Center for Biotechnology Workforce
- Esteemed Resource Persons of all educational and research institutions
- BIFP 2016 Fellows
- Forsyth Tech in house Staff – Ms. Allison, Ms. Mary, Ms. Shania, Ms. Julie



namaste