2016 Bioscience Industry Fellowship Project Modules
# Table of Contents

## Biotechnology, Careers, & the Future

Maha Gebara-Lamb, PhD; Denise Grant, MS  
Slides 3-26

## Innovation in the Biosciences: *An Interdisciplinary Approach*

Sarah Johnson, PhD; Peter Kim  
Slides 27-50

## The Cell and Biotechnology NSF-ATE module

Patricia Clinard Alfing, MS; Alphonse Mendy, MS  
Slides 51-82

## Using Instructional Design to Contextualize Advancements in Biotechnology through Collaboration

Tandeka Boko, MD; Caroline Smith, MAT  
Slides 83-115

## Observation of the Bioscience Industry Fellowship Project

Anuradha David, PhD  
Slides 116-147
Biotechnology, Careers, & the Future

The possibilities are endless.

Maha Gebara-Lamb, PhD
Denise Grant, MS
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)

NC Biotechnology Center (State Funded 501c3)

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

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

BioNetwork affiliated with NC CCs

Advocacy and Policy

Connect Researchers Fund Ideas Create Jobs

Biomanufacturing and pharmaceutical training consortium AS, BS, MS, PhD, Instructors
Some NC Educational and Industry Programs

Gateway University Research Park

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

The Joint School of Nanoscience & Nanoengineering (JSNN)

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

Wake Forest Innovation Quarter

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:

- Biocom Institute
- CLSI
- Southern California Biotechnology Center
- Biolink
- NBC²
- BABEC

Biomanufacturing and pharmaceutical training
AS, BS, instructors
2016 California Workforce Trends Report

Degree Requirements

- 6% High School Diploma
- 2% Community College Certificate
- 7% 2-Year Degree
- 63% 4-Year Degree
- 12% Graduate Degree
- 10% PhD Degree

Based on the quantitative survey of 248 California companies, Q1 2016

http://califescienceworkforcetrends.org/
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 capsaicin content in hot peppers
   • By ionizing chemical species, can separate by mass/charge ratio \( i.e. \) measure mass

   Capsaicin + 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
     • \textit{e.g.} take samples of product weight, get an average of samples
   • Calculate a 95\% confidence interval
     • Mean ± margin of error
Application to Biostatistics

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

Ways to display data.
High correlation, discuss if can claim causation?
What does it take? What is the evidence?
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

http://www.citymetric.com/skylines/why-we-should-be-farming-skyscrapers-1029
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
  • 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
Prepare for the Future of the Industry

• 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
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
Thank you!
Innovation in the Biosciences: An Interdisciplinary Approach

Peter Kim
Sarah Johnson
June 23, 2016
Biotechnology
“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

Joint School of Nanoscience & Nanoengineering (JSNN): http://web.nccu.edu/shepardlibrary/pdfs/centennial/BRITE.pdf
Piedmont Pharmaceuticals
vTv Therapeutics
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)
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)

63,000 trained workers

$73B total economic impact

ncbiotech.org
Career Options

Academia
- Teaching
- Research
- Service
- Development

Industry
- Profits
- R&D

Commercialization of New and Useful Technologies
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?
Biotechnology in Core Subjects

- Math
- Social Sciences
- English
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)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Capsaicin</th>
<th>Dihydrocapsaicin</th>
<th>Capsaicin</th>
<th>Dihydrocapsaicin</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>112618</td>
<td>101070</td>
<td>61164</td>
<td>29311</td>
</tr>
<tr>
<td>250</td>
<td>382254</td>
<td>300883</td>
<td>237266</td>
<td>120033</td>
</tr>
<tr>
<td>500</td>
<td>1319163</td>
<td>1030859</td>
<td>858021</td>
<td>425078</td>
</tr>
<tr>
<td>750</td>
<td>2262947</td>
<td>1527808</td>
<td>1395652</td>
<td>719254</td>
</tr>
</tbody>
</table>

Bhut Jolokia: 4214200 1123960 2675020 419430
Chili (cold): 448769 213557 284569 92424
Chili (hot): 213809 147144 126858 61585
Habenero: 3765515 1747350 2352865 585495
Hungarian: 146785 64935 86550 31085

Standards - Peak Area

Dried Peppers - Peak Area
Social Science in Biotechnology

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

Metrology in BMFR

- Safety
- ADME
- GFP Production
- Environmental Monitoring
- Chromatography
- Regulatory
- Solution / Media Prep
- Equipment Maintenance and Troubleshooting
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
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 a 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 the 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

<table>
<thead>
<tr>
<th></th>
<th>Run 1</th>
<th>Run 2</th>
<th>Run 3</th>
<th>Run 4</th>
<th>Run 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Temperature (°C)</td>
<td>120</td>
<td>120</td>
<td>80</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Hold Time (Min)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Ramp Rate (°C/min)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Final Temperature (°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hold Time (Min)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total length</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Pressure (kPa)</td>
<td>16</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>6</td>
</tr>
</tbody>
</table>
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
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.
Metrology makes it possible to formulate an oral dose, monitor its pharmacodynamics and pharmacokinetics, and its rate of excretion.
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
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.

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
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.
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

Martini et al., Visual Anatomy and Physiology 2nd ed. Applications manual
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
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

- Adam Boseman North Carolina Conference f Graduate Schools
- http://www.metrologycareers.com/
- http://www.nasa.gov/sites/default/files/missions_using_blackjack_receivers.png
- Krisstina Burgess, Ph.D
- http://www.nasa.gov/sites/default/files/missions_using_blackjack_receivers.png
- BTEC
REFERENCES

- [https://www.bio.org/what-biotechnology](https://www.bio.org/what-biotechnology) - Biotechnology Innovation Organization
- Tortora, Funke and Case, Microbiology, 10th ed., 2010, Pearson
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)

INTERDEPENDENT LEARNING

- Interactive Activities
- Community Building
- Critical Inquiry Modeling
- Pre-Class Assignments
- Metacognitive Principles
- E-Learning Technologies
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)
<table>
<thead>
<tr>
<th>Bone</th>
<th>Associated Bone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face</td>
<td>Cranium</td>
</tr>
<tr>
<td>Maxilla</td>
<td>Occipital bone</td>
</tr>
<tr>
<td>Maxilla bones</td>
<td>Parietal bone</td>
</tr>
<tr>
<td>Nasal bones</td>
<td>Frontal bone</td>
</tr>
<tr>
<td>Inferior nasal cavity</td>
<td>Temporal bone</td>
</tr>
<tr>
<td>Zygomatic bones</td>
<td>Sphenoid</td>
</tr>
<tr>
<td>Lacrimal bones</td>
<td>Ethmoid</td>
</tr>
<tr>
<td>Vomer</td>
<td></td>
</tr>
<tr>
<td>Mandible</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Skull and Associated Bones

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

Labeling Activity

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

Labeling Activity

Drag the labels from the bottom to the correct slots:
Center for Design Innovation

Pamela Jennings, PhD
Executive Director

Founding and Funding Partners

[Logos of various institutions]
Center for Design Innovation awarded HoloLens developer kits from Microsoft, to add hologram augmented reality to its line of research.

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

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)

Copyright © John Wiley & Sons, Inc. All rights reserved.
Medical Artifacts: Local doctor has a story to tell for each item in his extensive collection of old instruments

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.
Regenerative Medicine Essentials

Wake Forest Institute for Regenerative Medicine

Discover the education and training programs the Institute offers.

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**

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

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

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

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

ALPROLIX®
[Coagulation Factor IX (Recombinant), Fc Fusion Protein]

ELOCTATE®
[Antihemophilic Factor (Recombinant), Fc Fusion Protein]
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 the 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. Hematopoetic 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, Wakefield 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. Krisstina 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