WELCOME

to Chemical & Biological Engineering!
Welcome to Chemical & Biological Eng!

- Where do ChBE’s work?
- What do we do?
- What will you learn?
- ChBE program at CU
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- deb.rensshaw@colorado.edu
Chemical & Biological Engineering Fields

Biomedical (Biomaterials & Tissue Engineering)

Biotechnology & Pharmaceuticals

Computational Engineering

Energy

Interfaces & Catalysis

Nanomaterials & Nanotech

Polymers & Soft Materials

Protein Engineering & Synthetic Biology

Transport & Separations
Emerging Areas

• Bioengineering & Tissue Engineering

• Renewable Energy & Carbon Capture

• Materials/Nanomaterials
Industries by Undergrad Major – ’21 Class

CBEN industry

- Biotech & Pharma, 17, 37%
- Information Technology and Software, 7, 15%
- Renewable Energy, 1, 2%
- Oil & Gas, 1, 2%
- Chemicals, 1, 2%
- Consumer Goods, 1, 2%
- Facilities, 1, 2%
- Medicine / Medical Research, 1, 2%
- Consulting, 1, 2%
- Communications, 1, 2%
- Civil Engineering, 1, 2%
- Environment, 1, 2%
- Athletics, 1, 2%
- Materials, 1, 2%
- Medical Devices, 3, 7%
- Government, 2, 4%
- Religious, 1, 2%
- Medical Devices, 3, 7%
- Food, 4, 9%

CHEN industry

- Oil & Gas, 5, 16%
- Biotech & Pharma, 4, 12%
- Information Technology and Software, 4, 12%
- Renewable Energy, 4, 12%
- Aerospace, 2, 6%
- Automotive, 2, 6%
- Food, 1, 3%
- Medical Devices, 1, 3%
- Construction / Architecture, 1, 3%
- Chemicals, 1, 3%
- Environment, 1, 3%
- Cosmetics, 1, 3%
- Finance / Investing, 2, 6%
- Materials, 2, 6%
- Consumer Goods, 2, 6%
- Environment, 1, 3%
- Medical Devices, 1, 3%
- Oil & Gas, 5, 16%
- Biotech & Pharma, 4, 12%
- Information Technology and Software, 4, 12%
- Renewable Energy, 4, 12%

Continuing education: 10% of class
Biomaterials and Tissue Engineering

Knee or bone replacement: use hydrogels seeded with stem cells for new tissue formation
Genetic Engineering and Biotechnology

E. coli (bacteria) or yeast → protein drugs

How do we STABILIZE these drugs?
Brain tumors are difficult to treat with chemotherapy

Local recurrence

Chemotherapy drug-loaded polymer matrices

http://www.med.harvard.edu/AANLIB/cases/case1/mr3/033.html
Nanomaterials: Quantum Dots

QDs = semiconductor nanoparticles

Conjugated to DNA to detect cancer?
Genome Eng. for Biofuels

Catalysts & Enzymes: Biomass → Biofuels

Energy: Biofuels and Hydrogen

Hydrogen from H₂O & Sunlight
Solar Cells
Dynamic Windows
Solar Power Plants
Carbon Capture – Direct Air Capture

• 4 steps, then can bury CO₂ or make into products

1. Fan pulls air through
2. Air reacts with chemical & captures 80% of CO₂ from air
3. Take CO₂-rich solution and precipitate out solid calcium carbonate pellets
4. Heat pellets up & collect liquid CO₂
Material Science & Engineering

- Semiconductors
- Membranes
- Polymers
- Nanoparticles
- MEMS
- Labs on a Chip
- Plastics Upcycling
Semiconductors
Polymers and Soft Materials

- 3M’s Filtek™ Bulk Fill
  - Dental fillings
- Click Nucleic Acids (CNAs)
  - Drug delivery
  - Imaging
What Will You Learn?

Design

Controls

Lab

Technical Electives

- Tissue Eng & Med Devices
- Drug Delivery
- Pharma Biotech
- Metabolic Eng
- Immuno Eng
- Protein & Enzyme Eng

(Bio)Separations

(Bio)Kinetics

(Bio)Materials

Mass & Energy Balances

Fluids

Heat Transfer

Thermodynamics

Statistics

Heat Transfer (how fast)

Thermodynamics (how much)

Computing

Math

Chemistry (General, Organic, Physical, Biochemistry)

Biology

Physics

1 kg dry biomass
17996 kJ

$0.26 \text{ kg total}$

$2740 \text{ kJ}$

$0.74 \text{ kg}$

$8595 \text{ kJ}$

Chemistry (General, Organic, Physical, Biochemistry)
Bio Eng (BIEN) vs Chem & Bio Eng (CBEN)

• Why?
  – Students/alumni/employers: not enough bio in CBEN

• What changed?

<table>
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<tr>
<th>Old Course</th>
<th>New Course</th>
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<tbody>
<tr>
<td>Physics 2 &amp; Lab</td>
<td>Fundamentals of Biotech or Genetics</td>
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<tr>
<td>Chem Eng Separations</td>
<td>BIEN/CHEN Tech Elective</td>
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<tr>
<td>Process Control</td>
<td>BIEN/CHEN Tech Elective</td>
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<tr>
<td>Design Project</td>
<td>Bio Design Project</td>
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• BIEN: even better path for medical school

• Adding CHEN and BIEN minors
Which Degree Best Matches Your Medical Interests?

**Biological Engineering**
- Tissue Engineering
- Pharma, Vaccines
- Drug Delivery
- Gene Therapy
- Lab on a Chip
- In Vivo Imagining
- Medical Devices

**Biomedical Engineering**
- Biomechanics
- Mechanical
- Medical Devices
- Imaging & Diagnostics
ChBE Undergraduate Program

- Ranked 14th
- Challenging but rewarding
- Biotech building (east campus)
- 2 degrees + pre-med curriculum
- Active learning: screencasts, clickers, workshops
What Inspires You?

• Student groups
  – AIChe (American Inst. of Chemical Engs)
  – BMES (biomed)
  – CU Energy Club
  – ISPE (pharma)
  – SWE (women)
  – OXE, TBP (honor)

• Research
  – Volunteer
  – Independent Study
  – Senior Thesis
  – Pay
What Inspires You?

- TA for a ChBE class
- BS/MS
- Engineers without Borders
  - Nepal
  - Guatemala
  - Rwanda
Study Abroad

Sophomore year:
• Fall: Australia, Spain

Junior year:
• Fall: Ireland, New Zealand, Australia
• Spring: New Zealand (CHEN)
ChBE Mentor Programs

ChBE Peer Mentor Program
• Matches freshmen & sophomores with seniors

ChBE Alumni Student Mentor Program
• Match sophomores, juniors and seniors with alumni
We Are a Community...

...Reach Out!