Molecular Systems Bioengineering Laboratory

Transcriptional Regulation
Modulatory Oligonucleotides
Liver cell function in disease and cell-based devices
Cell and tissue phenotypes
Overcoming chemotherapeutic resistance

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Molecular Systems Bioengineering

**Biological Data**
- Genomes
- Proteomes
- Metabolomes
- Transcriptomes

**Engineering and Mathematical Principles**
- Thermodynamics
- Chemical kinetics
- Multivariate statistics
- Network & control theory

**Applications**
- In silico simulation of cells
- Medical diagnostics
- Validation of drug targets
- Targeted drug delivery
- Personalized medicine
Our Focus: Understanding & Controlling Gene Expression

DNA → RNA → protein

- Transcriptional Regulation
- Modulatory Oligonucleotides
- proliferation
- differentiation
- apoptosis
- And more…
Gene Regulation in Hepatocytes

Internal Programming

\[ \text{Signaling} \rightarrow \text{Transcription factors} \rightarrow \text{Changes in gene expression} \]

Environment

Cell phenotypes
- metabolism
- inflammation
- apoptosis
- proliferation

- Grad Students: Aina Andrianarijaona, Michelle Burley, Stephen Guzikowski, Joseph Vitolo, Hong Yang
- Collaborators: M. Ierapetritou (Rutgers CBE); I. Androulakis, S. Dunn, M. Yarmush (Rutgers BME)
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Antisense Oligonucleotides

**Inhibition by complementary base pairing**


**Normal Protein Production**

DNA → mRNA → Protein

**Antisense Inhibition**

DNA → mRNA → No Protein Production

- Antisense oligonucleotides are being employed as therapeutics, functional genomics, and in tissue engineering
- Efficient delivery remains a barrier to widespread application
Critical Issues in Therapeutic Oligonucleotides

• Design of oligonucleotides with high affinity/kinetics for target mRNA
• Delivery of oligonucleotides to site of action
  - Polymer/DNA biophysics
  - Structure/activity relationships
  - Actuated intracellular release reagents
  - Peptide targeted delivery

• Postdoctoral Associate: Li Kim Lee
• Grad Students: Lavanya Peddada, Sumati Sundaram
• Collaborators: D. Devore and J. Kohn (NJ Center for Biomaterials)
• Funding: NIH R01 Grant, ACS-PRF Grant
Gene Expression in Chemotherapeutic Resistance

- **Grad Student**: Salaheldin Hamed
- **Collaborators**: D. Banerjee (UMDNJ Pharmacology)
- **Funding**: Charles & Johanna Busch Memorial Fund; NSF IGERT Training Fellowship