Team 20: Muscle Glue

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Team names, catchy intro.
- Mussels make adhesive
  - strong
  - good underwater
- Why do we want to make it? Useful in many industries
  - Shipping
  - Construction (specifically underwater)
Our target market is the medical industry. Since the human body is 70% water, surgical glues need to be both strong and water resistant
Description of what medical glues are (put on wound, close, heal, dissolve)
A good medical adhesive must be...
- Biocompatible – can’t kill the person you put it in
- Aqueous Environments (Body) – functional in 70% water environment
- Affordable – hospitals have to be able to get it to use it
- High Strength - can’t have the person coming back apart
- Safe and reproducible – can’t destroy environment when producing or kill workers
Decide between multiple manufacturing methods for the protein itself.
- Many different proteins involved in adhesion, need to decide which one is best
- Develop simulation to tell what size of different equipment and the efficiency that they have.
- Needed to scale up from lab scale which is just a few mL at a time, to industrial scale where our bioreactor is 4500 L.
Economically optimize process to produce the product while costing as little as possible.
Ends of byssal thread on mussel:
Important proteins in pink and blue, 1 on the outside in salmon
Mgfp1 3/5 sticky, hard to separate
Mgfp 1 easy to separate, not sticky
Mgfp 151 = mgfp 5 with parts of the molecular structure of 1 on either end. Sticky and separable
Mgfp 151RGD even more sticky even more separable. How is this different than 151?
Extraction from mussels – what is done currently with mussel adhesive products on the market

We know this will work, but it is not environmentally sustainable. Would make terrible chem. Eng design project.

Recombinant hosts (don’t fully explain recombinant here, just mention you’re outsourcing work to a single celled organism. It gets explained later)

CHO (Chinese Hamster Ovaries): Expensive, very complex

Yeast: high density in bioreactor, not expensive, medium complexity

E. Coli: Fast, cheap, simple. Our protein is simple and we have research data.
Market Evaluation

- Market will be 5% of target surgery types
- Goal of producing 370 kg/yr

For process sizing
Basic idea of what we’re doing:
[explain recombinant dna] > grow e coli in bioreactor > tell bacteria to produce protein > separate protein from other stuff > activate stickiness with chemical reaction > ??? > profit
More in depth explanation of equipment (quickly point out key items).

Bioreactor, grow cells
Bead mill – break cells open, giving access to contents. Delicious, juicy contents.
Centrifuges – separate heavy from light
Affinity column – our protein sticks to gel inside, wash other stuff out
Membrane adsorption – same basic idea as affinity column
Diafiltration – small things can go through holes, like a strainer (familiar example: dialysis)
Economics

- Varied batch speed and size
- Optimal case:
  - 1 bioreactor
  - 3960 annual production hours
  - $7.7m profit (15 year lifespan)

Plot has number of bioreactors on one axis, number of hours per year on other, profit vertically.

  important part is high point (labelled)

Profit results from breaking down capital costs and startup over 15 year lifespan
Obstacles

- Lack of available data
  - Kinetic data for each reaction
  - Balancing biochemical reactions
  - Sequence and properties of the protein
• Lab scale to Industrial Scale
• Safety and Toxicity
Really the only thing that needs to be done is to test in the real world and see if it actually works (don’t word like that)
Build pilot plant to test process, test product, see if we need to change thickness to make more applicable, etc.
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Questions?