**The Pros and Cons of Being Pro-Protein Engineering**

Ever since high school biology, students have known about the importance and prevalence of proteins. Whether it is in the food that sustains us, in the cells that compose us, or in the medicine that heals us, protein proves itself to be an integral macromolecule to human function and lifeforms in general.

However, the industrialized use and production of useful protein types is accompanied by practice of overtly unsustainable methods in order to increase profits, like the infamous overbreeding and use of factory farms. One area of unsustainability that protein synthesis has a direct influence on and that the public is not completely aware of is the overpricing of drugs in this current era, and one possible solution for this is simple optimization.

Background of Protein Synthesis and My Experience

Proteins are naturally synthesized in the bodies of living things, but in order to be utilized for products and large-scale use, we need to use a process that is usable in labs and factories outside of cells in our bodies and is also relatively efficient. One modern and popular method in labs is named Fmoc Solid-Phase Protein Synthesis or Fmoc SPPS, which capitalizes on the careful linking of amino acids one by one to a growing peptide which is anchored by a solid resin to hold it during the procedure [1]. The main characteristic that sells this method is that each individual amino acid comes protected with an fluorenylmethyloxycarbonyl group (fmoc) or in other words an attachment ensuring that amino acids will not connect unless the producer wants them to, allowing him or her to be deliberate and precise in making the peptide that they want [1]. While this method of synthesis may seem complex to the layman, it comes down to a one-by-one linkage like adding links to a chain.

Recently as an assistant in research, I have undergone Fmoc SPPS and noticed many positives and negatives. As promised in the literature, the process allowed me to be very precise, and seems to guarantee that and a good yield for any scientist that thoroughly understands the standard procedures. I produced many different peptides repeatedly, also noticing that the process was rather monotonous yet still nerve wracking to do by hand. It takes time and has many mistakes that can be made if not experienced, though in other labs it has been automated if allowed by the budget. It can be done with minimal training compared to many other procedures in research labs, but this relative simplicity comes some inefficiency that begs to be optimized.

Applications in Industry and Improvements

In order to be viable to be used in factories at an industrial scale, Fmoc SPPS is adapted to be more efficient and with less room for human error than its research lab counterpart and being able to produce large amounts of synthetic protein proves its worth. Solid-phase methods like Fmoc SPPS have been developed to require less reagents, purification, and time to make, as well as making longer and more complex peptides that easier adapt to different purposes [2].

Many subgroups of medicine consist of proteins in the active ingredients, such as vaccines applying antibodies against disease or inhibitors and other enzymes used support inner processes in a weakened body when some cannot produce those proteins on their own. One such peptide is Fuzeon, “a 36-amino acid HIV fusion inhibitor that has been on the market since 2003” [2]. Being large and needed in a high dosage, efficient peptide synthesis makes the medication viable, likely saving many lives just by mimicking proteins, the jacks-of-all-trades of the body.

Unsustainability of Industrial Use of Proteins

Protein-based medication is effective at treating diseases in a nearly natural way despite often being synthetic, though the category has a pitfall that is one of the first conflicts engineers notice: price. Fuzeon, as vital as it can be, has marketing prices driven up because of the sheer number of complex steps and necessary reagents and components [2]. Furthermore, antibody medications meant to treat cancer have had doubled in average price just in the last decade [3]. I conjecture that this recent, continual increase in price results from the increased quality of the proteins and in turn higher production costs. This causes massive markup in price by pharma companies to maintain profit and makes the industry unsustainable as consumers who need the medication are unable to afford them.

A substantial fraction of the resources in the protein synthesis go towards to the step of purification, which simply put, occurs when the impurities or mistakes in amino acid linkage are removed from the batch. As impurities increase, yield decreases [2]. There are multiple obstacles to overcome if chemical and bioengineers want to lower prices by chain reaction, but by minimizing side products, that will directly cause a drop in costs. Nonetheless, since optimization is not that simple as a homework problem, much more research is required by those in the field.

Fmoc peptide synthesis, an artificial process mimicked from nature, has managed to maintain both its relative simplicity and potency. Starting out as a manual procedure in labs and becoming an industry-wide process has proved that as a concept, protein synthesis has come a long way in producing helpful products but has a long way to go before supporting a stable industry. The sheer utility of proteins combined with the unsustainability of current practices shows that synthetic proteins has massive potential to be tapped, as well as a greater potential to be misused.

References

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