BIO-PHARMACEUTICAL BIOTECHNOLOGY AND IMPROVED HEALTH DELIVERY

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OUTLINE

- INTRODUCTION
- PHARMACEUTICALS, BIO-PHARMACEUTICALS AND BIOTECHNOLOGY
- BIO-PHARMACEUTICAL BIOTECHNOLOGY
- TECHNICAL ASPECTS OF PROTEIN DRUG DISCOVERY
- SOME TYPES OF PHARMACEUTICALS PRODUCTS AVAILABLE IN THE MARKET
- BIOPHARMACEUTICALS AND HEALTH CARE DELIVERY
- CONCLUSION

INTRODUCTION

- In the 20th century, innovations through science and technology in health and healthcare has led to quality healthcare delivery services, quality of life and a rise in life expectancy worldwide (Nigeria?).
- In 1982, Eli Lily corporation produced the first approved genetically engineered pharmaceutical product, the human insulin. This was made possible through science of biologic technology (biotechnology).
- Innovations such as ***Protein based drugs*** like ***erythropoietin*** and fast acting insulin are out of reach for millions of people in developing countries.
- To help address this, there is need for massive deployment of biotechnology that can be effectively used in partnership with conventional public health practices in developing countries.

PHARMACEUTICALS, BIO-PHARMACEUTICALS AND BIOTECHNOLOGY

- Pharmaceuticals are medical products that are ***chemically*** developed to cure, treat, find or prevent any number of diseases our bodies may develop in our lifetime.

- Bio-pharmaceuticals are ***biologic drugs*** made from ***living organism***, created through bioengineering or biotechnological processes.

- Biotechnology is not one kind of technology, but many. The three kinds of biotechnology tools are working with cells, working with proteins and working with genes. Biotechnology is therefore a ***toolbox*** filled with many different kinds of living cells, their component molecules and different ways to use them.

BIO-PHARMACEUTICAL BIOTECHNOLOGY

- Pharmaceutical biotechnology, a field in which the principles of biotechnology are applied to the development of drugs. Still a relatively new and growing field.
- The products of this principles, called bio-formulations, biologics which pharmaceutical companies market use recombinant DNA technology to design more effective protein based drugs such as erythropoietin and fast acting insulin. Widely used in prevention, diagnosis and treatment of several diseases. The future of pharmaceuticals belongs to **protein based therapeutics**.
- Bio-pharmaceutical biotechnology refers to the application of biochemistry and biotechnology for manufacturing drugs, gene therapy as well as gene testing. This is achieved by manipulating and modifying organisms usually at molecular level.

TECHNICAL ASPECTS OF PROTEIN DRUG DISCOVERY (QUALITATIVE PRINCIPLES INVOLVED)

For large-scale protein synthesis, recombinant DNA technology is used:

- This include extracting the DNA or RNA of interest from biological samples e.g. cells or tissues.
- Integrating the DNA encoding the protein of interest into an appropriate cloning vector i.e. finding suitable host cells to express the protein e.g. Escherichia coli, yeast, insect cells, plants or animal.
- Designing to obtain highly pure proteins.
    - *Chromatographic purification via size exclusion,*
    - *Ion exchange*
    - *Hydrophobic interaction*
    - *affinity*

TECHNICAL ASPECTS OF PROTEIN DRUG DISCOVERY (QUALITATIVE PRINCIPLES INVOLVED) CONTINUED

- Protein engineering to generate mutants and/ or facilitate post-translational modifications.

N.B. Protocols employed must not cause side reactions such as deamidation which can change properties of protein drug.

- Drug finally freeze-dried.
- Packaged for delivery.

TECHNICAL ASPECTS OF PROTEIN DRUG DISCOVERY (QUALITATIVE PRINCIPLES INVOLVED) CONTINUED

- Assessment of stability/ shelf of the Drug
  - *Various experimental techniques are involved; include*
    - Determining

      (I) The concentration of functional protein and its potency over-time

      (II) The effects of any contaminants

      (III) Potential toxic aggregates

      (IV) Product degradation rates

      (V) Co-valent modifications that may occur over time

TECHNICAL ASPECTS OF PROTEIN DRUG DISCOVERY (QUALITATIVE PRINCIPLES INVOLVED) CONTINUED

- These are quality assurance measures that define the conditions under which the drug can be transported, stored and administered to the patient.

DETERMINING OR DECIDING HOW TO DELIVER THE DRUG TO THE DESIRED LOCATION IN HUMAN BODY.

- The various delivery routes available includes:
  - *Oral*
  - *Pulmonary*
  - *Nasal*
  - *Transmucosal*
  - *Transdermal*
- Each has its advantages and disadvantages
- The selection of these routes, could/may be determined by e.g.
  - *Rate of release*
  - *Clearance of drug from the system*

  These may impact on the dosage level

TECHNICAL ASPECTS OF PROTEIN DRUG DISCOVERY (QUALITATIVE PRINCIPLES INVOLVED) CONTINUED

- There are various options that must be considered when determining which delivery method should be adopted

PATENTING OF BIOPHARMACEUTICAL PRODUCT/ENTITY

it is important to patent any biomolecule which might have pharmaceutical value. WHY? Patent prevents others from exploiting the innovation for up to 20 years .

There are steps involved in patenting and there are details to be considered at each step of patenting.

- *Note: naturally occurring products cannot be patented unless they involve substantial post-extraction development.*

Conducting clinical trials

- *Prior to the trials, approval need to be obtained from appropriate regulatory authorities; US Food and Drug administration, NAFDAC in Nigeria, etc.*
- *The manufacturing entity must comply with industry safety and quality standards*

TECHNICAL ASPECTS OF PROTEIN DRUG DISCOVERY (QUALITATIVE PRINCIPLES INVOLVED) CONTINUED

- *After the drug enters the market, post-marketing surveillance must be carried out to track any side effects and adverse reactions*
- *It is during clinical trial that pharmacokinetics and pharmacodynamics experiments reveal the drugs fate and its mode of action in the body and where the drug potential toxicity and immunogenicity are assessed.*
- *Clinical trials are in stages*

SOME TYPES OF BIOPHARMACEUTICALS PRODUCTS AVAILABLE IN THE MARKET

- Cytokenes, interferons (Rabif, interferon beta-la)
- Interleukens (e.g. Ontak, Denileuken difltox)
- Turmor necrosis factors (e.g. Beromun, Tasonermin)
- Growth factors (e.g. Neupogen, Filgrastim)
- Hormones (e.g. Humalog, Insulin, Lispro)
- Enzymes (e.g. Benefix, Nonacogalfa)
- Antibodies (e.g. Avastin, Bevacizumab)
- Vaccines (e.g. Engerix B, Hepatitis B viruscoat)

Therapeutic strategies

- Nucleic acid- and cell-based
- Gene therapy &Stem cells

BIOPHARMACEUTICALS AND HEALTH CARE DELIVERY

- According to a report by analysis group, 'Innovation in the Bio-pharmaceutical Pipeline: A multi-dimensional view', many novel scientific strategies are opening up new possibilities for fighting diseases.
- The report which examined the bio-pharmaceutical pipelines from many different angles to capture the breadth and focus of immediate and ongoing research found that nearly three times as many drugs for rare diseases and conditions are in the pipeline with a decade ago.
- Findings also show that over 5,000 potential new medicines which may become available to patients in the United States are in the pipeline and to which enough funding is made available

BIOPHARMACEUTICALS AND HEALTH CARE DELIVERY CONTINUED

- Unfortunately for Nigeria, statistics or structure to fund and support these endeavours are not in place. In funding, the United states has more than $500 billion been invested in R&D since 2000 while Nigeria still lacks behind.
- With hundreds of thousands or even millions of compounds that may be screened as part of large scale compound libraries, the vast majority are eliminated prior to testing in humans through laboratory screening and pre-clinical testing. It has been known of those reaching clinical trial phase, about 12% are ultimately approved by FDA after an average of 10 to 15 years of development with an average of over $2.6 billion investment.
- The percentage of drugs development which are highly rated is notably high in neurology (84%), cancer (80%) and psychiatry (79%)

BIOPHARMACEUTICALS AND HEALTH CARE DELIVERY CONTINUED

Other notable examples of how bio-pharmaceutical biotechnology has helped in health care delivery include:

- Development of new generation Hepatits C medicines
- Introduction of personalized medicine is also becoming an integral part of the R&D process.
- Potential new treatment for dangerous mutation in infants such as Hypophosphatasis (A rare inherited bone disease)
- Unravelling the mysteries of Alzheimer's disease

CONCLUSION

- A majority of therapeutic drugs in the current market are bioformulations, such as antibodies, nucleic acid products and vaccines. Such bioformulations are developed through several stages that include: understanding the principles underlying health and disease; the fundamental molecular mechanisms governing the function of related biomolecules; synthesis and purification of the molecules; determining the product shelf life, stability, toxicity and immunogenicity, drug delivery systems; patenting and clinical trials.
- Biopharmaceuticals holds the aces for the treatment of rare diseases and conditions in the healthcare delivery system.

REFERENCES

- John Wiley. (2003). Biopharmaceuticals: Biochemistry and biotechnology.
- Hum Genomics. 2010; 4(3): 218-219. Accessed online via https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3525971/

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