**TEXT FOR VIDEO : ESSENTIAL TECHNOLOGIES – PHARMACEUTICALS**

**\*Slide #3 - Pharmacuetical Drugs**

This session aims to provide an overview of the essential technology domain of pharmaceuticals.

Before we begin, let us clarify a few terms and expressions that we will be using widely in this session.

What is a pharmaceutical drug exactly? [CLICK]

For the purposes of this course, a pharmaceutical drug is any substance or compound that is used to cure, treat, or prevent disease. It may also be referred to as a pharmaceutical, pharmaceutical product, medicine, medication, or simply a drug.

We can distinguish between two broad categories of drugs, based on the manner in which they are produced and administered. [CLICK]

Small-molecule drugs are low-molecular weight compounds that are chemically synthesized and then formulated into a tablet that is given orally to the patient, [CLICK]

whereas biological drugs or biologicals are high-molecular polypeptides, proteins and antibodies that are produced via biotechnological/recombinant processes, and typically administered by injection to the patient. [CLICK]

**\*Slide #4 – Pharmaceutical Development Process**

How are pharmaceutical drugs developed?

For simplicity, we can consider the drug development process to be divided into 3 broad stages: [CLICK]

* It starts with **Preclinical Development**, which essentially occurs entirely in the laboratories, in order to eventually produce what is termed a **New Chemical Entity (NCE)**. [CLICK]
* This is then followed by the **Clinical Development** stage, which primarily occurs in hospitals and clinics.

It essentially involves testing the NCE from the Preclinical Stage in humans for Safety and Efficacy against the intended disease(s).

At this stage, the NCE is now referred to as the **Investigational New Drug (IND)** upon approval by a suitably accredited national or regional regulatory body, such as the Food and Drug Administration (FDA) in the US and the European Medicines Association (EMA) in Europe. [CLICK]

* If the Clinical Development stage goes well and the clinical trials are successful a **New Drug Approval (NDA)** is granted, which leads to the final stage, that is a **Branded** **Product** [CLICK]

and the **post-approval and marketing phase**. [CLICK]

* The time it takes from the commencement of Preclinical Development to the Approval of a new drug is about 10-15 years, and costs about USD$2.6 billion, based on the last study (in 2014) from the Tufts Center for the Study of Drug Development.

So, drug development of a new drug is lengthy and very expensive, but also a highly inefficient process with low success rates. [CLICK]

Given the high costs of drug development, prior to the start of the Drug Development Process, a patent that protects the drug is filed.

This patent is valid for 20 years, afterwhich the drug becomes available to any other parties who may wish to produce and market a copy or **generic version** of the drug, usually at a lower price than the branded product.

Consequently, most of the leading pharmaceutical companies from developing countries are primarily involved with the manufacture of generic pharmaceutical products rather than the development of new drugs entirely.

Thus, the development of new drugs is almost exclusively confined to companies in the highly industrialized countries, such as the US, Western Europe and Japan.

This also inherently implies that most of the available drugs are mostly tailored for those populations and often less adapted to the rest of the world population, especially developing countries. [CLICK]

Consequently, since biological drugs are large macromolecules, such as proteins, they are sensitive to temperature and and must always be stored at refrigerated temperatures, and thus require  a [temperature](https://en.wikipedia.org/wiki/Temperature)-controlled [supply chain](https://en.wikipedia.org/wiki/Supply_chain) or cold chain. Vaccines and antibody drugs also fall into this category. [CLICK]

**\*Slide #5 - Essential Medicines**

Since the creation of the modern Food & Drug Administration in 1938, there is almost 1’500 drugs that have been approved.

Therefore, for any country wishing to establish a repertoire of essential medicines that the country must aim to have, in order to ensure adequately meeting national medical needs, choosing which medicines to prioritize can be a significant challenge, especially if lacking the suitable expertise for such a task. [CLICK]

In order to confront this challenge, the World Health Organisation (WHO) judiciously assembled an Essential Medicines List.

And WHO defines **Essential medicines** as those medicines or pharmaceutical products that satisfy the priority health care needs of the population. [CLICK]

They are selected with due consideration to **public health relevance**, their safety and efficacy, [CLICK]

and cost-competitiveness. [CLICK]

In other words, essential medicines are intended to be available within the context of functional health systems at all times in adequate amounts, in the appropriate dosage forms, with assured quality and adequate information, and at a price the individual and the community can afford. [CLICK]

Thus, the Essential Medicines List aims to serve as a **Model Medicines List** or some sort of template that countries can then adapt and develop their own national Essential Medicines Lists.

It can assist national decision-makers in reducing costs by helping them identify priority medicines to meet their country’s health needs.

In high-income countries, the list helps to provide insurance companies, for example, with a neutral, gold-standard list for reimbursement. [CLICK]

\*Slide #6 - Disease & Poverty Link

We now look at the link between poverty, disease and access to essential medicines.

This slide shows that the countries with the lowest per capita health expenditure, indicated in red, are also some of the poorest countries in the world.

Pharmaceuticals account for up to 30% of health expenditures in transitional economies, while this figure rises to as high as 66% in low income countries.

Clearly, a lower per capita expenditure on health, implies less availability of essential medicines. [CLICK]

\*Slide #7 - Disease & Poverty Trap

[CLICK] Interestingly, according to the WHO, a previous survey carried out in Uganda showed that for certain nationally listed essential medicines, out-of-pocket prices for patients were over 13 times higher for branded products than the international pricing reference.

And even for generics, the prices were still almost 3 times higher than the international reference.

This is clearly a surprising finding, and reveals a vicious cycle, where the Poor will simply get poorer AND sicker. [CLICK]

\*Slide #8 - Neglected Tropical Diseases

Besides the general diseases that tend to affect the whole world, in general, tropical & subtropical regions have additional diseases that are particularly endemic in those regions, collectively known as the **Neglected tropical diseases** (NTDs).

The term “neglected” highlights the fact that the diseases affect mainly poor and marginalized populations in low-resource settings.

NTDs are a diverse group of communicable diseases that prevail in tropical and subtropical conditions in 149 countries.

They affect more than 1.4 billion people (including more than 500 million children), costing developing economies billions of dollars every year.

These diseases are contrasted with the big three diseases ([HIV/AIDS](https://en.wikipedia.org/wiki/HIV/AIDS), [tuberculosis](https://en.wikipedia.org/wiki/Tuberculosis), and [malaria](https://en.wikipedia.org/wiki/Malaria)), which relatively receive greater treatment and research funding. [CLICK]

\*Slide #9 - Neglected Tropical Diseases : WASH

There are about 17 neglected tropical diseases, and examples include: chagas, dengue & chikungunya, sleeping sickness, and trachoma.

NTDs thrive in areas where there is lack of basic sanitation. [CLICK]

Thus, **Water, Sanitation and Hygiene** services are also critical to care for the people who have many of these diseases, and for accelerating and sustaining progress on neglected tropical diseases overall.

Hence, you also see the logo for SDG 6, which calls for Clean Water & Sanitation, to highlight the overlap between these SDGs. [CLICK]

\*Slide #10 - Emerging Health Challenges - NCDs

Besides infectious diseases, an emerging and potentially greater health challenge is in the form of Non-communicable diseases (NCDs)

NCDs account for 63% of all deaths, i.e. 36 million out 57 million global deaths.

And 80% of NCD deaths occur in low- and middle-income countries.

So, NCDs are not only a health problem but a development challenge as well. [CLICK]

Within NCDs, cardiovascular and mental health are increasingly posing immense challenges. [CLICK]

\*Slide #11 – NCDs: Type 2 Diabetes

Within cardio-vascular diseases, Type 2 diabetes is increasing at an alarming rate.

The number of people with Type 2 **diabetes** has risen from 108 million in 1980 to 422 million in 2014.

In particular, diabetes prevalence has been rising more rapidly in middle- and low-income countries.

Diabetes is one of the leading causes of death today, and the majority of these deaths indeed occur in low and middle income countries. [CLICK]

**\*Slide #12 – NCDs: Mental Health**

In Mental Health, Epilepsy and Depression are particularly noteworthy. [CLICK]

**Epilepsy** is a chronic non-communicable disorder of the brain that affects people of all ages.

Approximately 50 million people worldwide have epilepsy, making it one of the most common neurological diseases globally.

Nearly 80% of the people with epilepsy live in low- and middle-income countries.

However, about 3/4 of people with epilepsy living in low- and middle- income countries do not get the treatment they need. [CLICK]

Another mental health disease of high significance is **Depression**.

According to WHO, depression is the leading cause of disability worldwide, and is a major contributor to the overall global burden of disease.

It affects around 350 million people worldwide and this number is projected to increase. Fewer than half of those people affected have access to adequate treatment and health care. [CLICK]

**\*Slide #13 – Emerging Innovations: Introduction**

The issue of improving access to essential medicines to developing countries is a massive and multi-factorial challenge.

One of the biggest issues remains economic: cost & affordability. But even if the budget for medicines is available sometimes, other factors may undermine the ultimate mission of access.

Such factors may include fake medicines and lack of suitable infrastructure (e.g. cold chain for vaccines).

There are various technology initiatives that are making a concerted effort to tackle some of the challenges mentioned before.

With respect to reducing cost and ensuring adequate supply of high quality medicines, local manufacture of medicines is touted as one of the potential strategies.

However, besides the skills and personnel to realize that, an initial challenge is the prohibitive cost of establishing a pharmaceutical manufacturing infrastructure. [CLICK]

\*Slide #14 - Continuous Manufacturing – I (I disappear from the screen; only the image)

An emerging and very promising bio-manufacturing technology is Integrated Continuous Manufacturing (ICM). There are various intitiatives working on this technology.

One of the best examples is the Novartis-MIT Center for Continuous Manufacturing program, which has given rise to a spin-out company, Continuus Inc, to industrialize these developments.

Integrated Continuous Manufacturing entails producing finished drug tablets from raw chemical ingredients through a fully integrated, non-stop, end-to-end continuous process.

In other words, materials to be processed are being introduced continuously in smaller quantities, which implies working with smaller volumes.

Whereas, in batch processing the materials to be processed are all introduced at once in the exact quantities required for the final product. This requires large volumes and larger infrastructure if high volumes of product are being produced. [CLICK]

\*Slide #15 - Continuous Manufacturing – II **(I re-appear on the screen)**

According to the company Continuus, this allows to produce tablets in just two days, using a single facility with a footprint of 1/10 smaller than existing batch plants.

Also, this method leads to improved quality, as product verification can occur in real-time and allow for real-time release of pharmaceuticals.

Thus, overall it

-Lowers investment and operating costs, higher energy efficiency, and lower CO 2 emissions

-And provides shorter time to market and greater flexibility in production across the entire product lifecycle.

- It is an «automated» bio-manufacturing technology, requiring less human interention and thus, in principle, relatively easier to operate than conventional systems.

The advantages provided by this bio-manufacturing technology are potentially attractive for enabling local pharmaceutical in developing countries. [CLICK]

\*Slide #16 – Fake Medication: mPedigree

Fake medicines account for almost a third of medicines in Africa. One study, published by the American Journal of Tropical Medicine and Hygiene, found that in just one year, fake and poorly made malaria drugs contributed to the deaths of more than 100,000 children across Africa. The British think-tank, International Policy Network, estimates that globally, 700,000 deaths a year are caused by fake malaria and tuberculosis drugs. [CLICK]

A company from Ghana, mPedigree, has been hard at work to tackle this serious problem.

How does it work?

Pharmaceutical Manufacturers can sign up on to the mPedigree scheme/platform, where they can upload pedigree information of each pack of medicine into the central registry.

When consumers buy a product made by a manufacturer participating in the scheme, they are able to query the pedigree information stored in the registry by means of a free SMS message.

An automatic response from the registry certifies whether the particular product is truly "from source" or not.

Today, mPedigree claims it has labels on more than 500 million drug packets. And Clients also include giant drug companies, such as AstraZeneca, Roche, and Sanofi. [CLICK]

\*Slide #15

There are various other technology initiatives that promise to improve access to much needed essential medicines, which we cannot cover, unfortunately, during this lecture, due to time constraints.

However, references for further reading have been provided at the end. They cover other initiatives to fight fake drugs, provide cold chain to ensure safe access to vaccines and more…

This now brings us to the end of this lecture. Good-bye!