TECHNICAL COOPERATION

Quality Infrastructure for Green Transformation in the Pharmaceutical Sector

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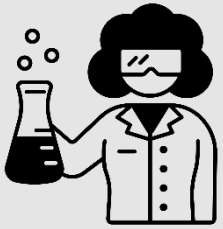
Pharmaceutical value chain and QI aspects

1 Research & Development

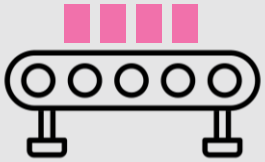


- Drug Discovery - Identification, screening and synthesis of new molecules for therapeutic efficacy. Preclinical trials.
- Development of a new formulation.
- **Validation** of processes.
- **Clinical trials**

2 Approval process

- Submission of dossiers to regulatory authorities. Assessment & **quality control testing in accredited laboratories.**
- **Inspection** in line with Good Manufacturing Practices (GMP).

3 Manufacture



- Commercial manufacture in **qualified** premises using **calibrated eqipment**
- **Certified** inputs and production processes
- Compliances with compendial methods and **standards.**

4 Marketing & distribution

- Storage in qualified warehouses
- Distribtion to wholesalers, hospitals, retailers; cold chain if required.
- Post **Market surveillance**
- Pharmacovigilance

GxP

GCP
Good clinical practices

GLP
Good laboratory practices

GMP
Good manufacturing practices

GDP
Good distribution practices

Environmental aspects – energy, water, waste

- Along the value chain, the pharmaceutical industry **consumes significant amounts of water and energy** to operate facilities, provide air conditioning (HVAC system) and carry out production processes. According to the World Economic Forum 2022 report, the pharmaceutical industry is responsible for **4.4% of global emissions**.
- Pharmaceutical production generates **large quantities of waste and waste water.** The production of **1 kg of active pharmaceutical ingredients** (APIs) can require up to **100 kg of starting materials.**
- If not treated properly, pharmaceutical wastewater can affect the **water quality** in rivers and lakes and even lead to **antimicrobial resistance**.
- **Patients** often contribute to an unnecessary, additional burden on the environment by **disposing of medicines down the sink or toilet**,

Active Pharmaceutical Ingredients (APIs)

- Key input for pharmaceutical manufacturing - responsible for the medicinal effects. Main producing countries: India and China. Lower production costs at large production quantities.

CHALLENGE

- High levels of API residues found in the waste water effluent from producers and in lakes / rivers in the region (example India / Hyderabad, similar reports from other countries such as China and Pakistan).
- Lack of adequate treatment facilities.
- Weak regulatory enforcement.
- Environmental and health problems.
- Impact on antimicrobial resistance.

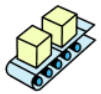
Good Manufacturing Practices (GMP)

GMP standards ensure that products are consistently produced and controlled.

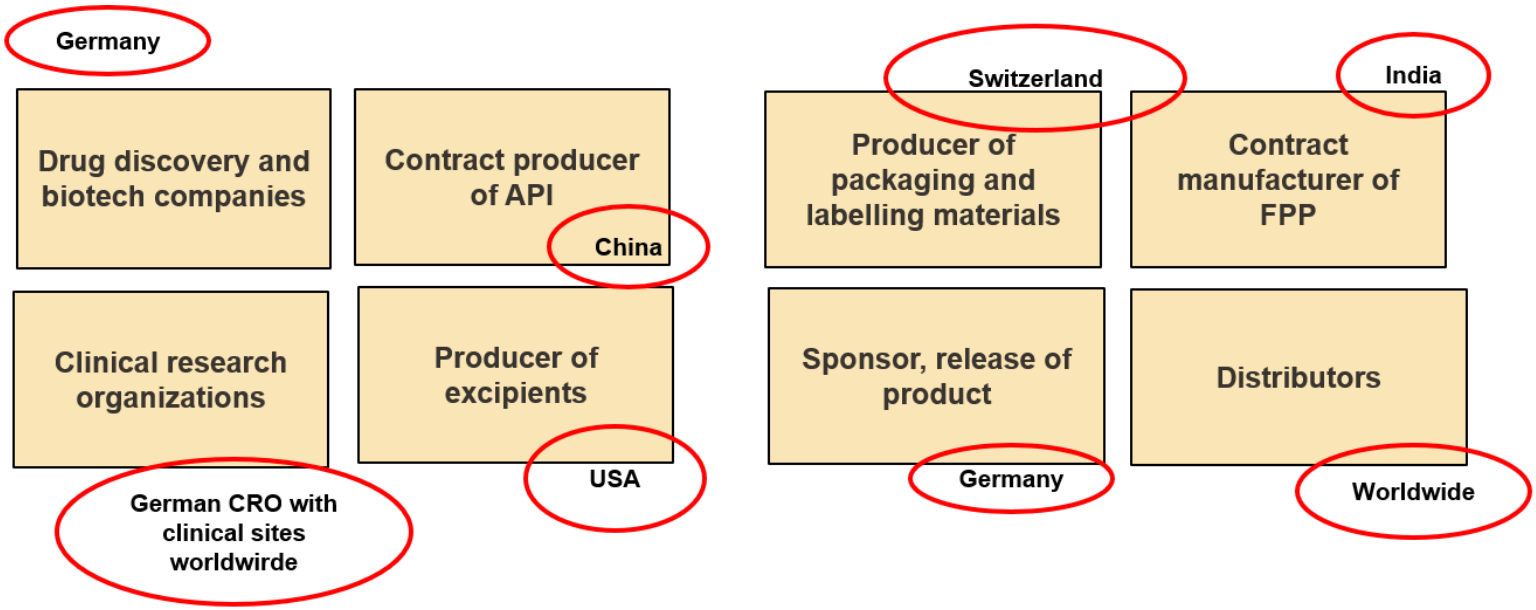
Main risks in production: contamination, incorrect dosing of APIs, wrong labels.

GMP standards do not cover environmental emissions.

Key GMP aspects

- ✓ Premise and equipment 
- ✓ Materials 
- ✓ Production and packaging 
- ✓ Qualification and validation 
- ✓ Lab controls 
- ✓ Storage and distribution 
- ✓ Personnel and training 
- ✓ Sanitation and hygiene 
- ✓ Documentation 
- ✓ Self-inspection 
- ✓ Quality management 

Global pharmaceutical supply chains



Example of a potential medicinal product ‚manufactured by a German firm‘!

CHALLENGE

While manufacturers in the EU are required to test the **environmental compatibility** of new pharmaceuticals and wastewater / waste management is controlled, other regions often have fewer environmental regulations in place or implementation is not strictly enforced.

Recommendations

- Pharmaceutical manufacturers should qualify their (global) suppliers and include green transformation / environmental aspects in the **inspection and verification.**
- The inclusion of **environmental considerations** and related verification requirements in international **GMPs** would be a way to encourage authorities in third countries to support the achievement of a minimum level of environmentally sustainable pharmaceutical production.
- The weight of **environmental risk assessment (ERA)** in the marketing authorisation process should be strengthened, and environmental emissions outside the EU should be included in the assessment.
- International co-operation could integrate environmental considerations into the strengthening of regulatory authorities and the private sector and stimulate **innovation in renewable energy** in operations and transport and the use of electrical sources where possible.

Opportunities

- In many of PTB's partner countries, the pharmaceutical sector is starting to invest in green energy sources (in particular solar panels) and more efficient, in-house wastewater treatment plants.
- Pharmaceutical strategy for Europe (2020) focuses on reducing the impact of harmful substances on the environment and encourages the use of electrical sources where possible.
- Pharmaceutical companies are increasingly using environmental management systems in accordance with ISO 14001 to systematically record and analyse their use of raw materials.
- Members of the "Pharmaceutical Supply Chain Initiative", check their suppliers (e.g. API) on the ground not only for production quality (GMP), but also for sustainability criteria.

Example: CHEM21, funded by the EU and the pharmaceutical industry, is developing more environmentally friendly manufacturing processes and reducing the use of expensive and toxic materials in drug production. One significant result was the more cost-effective and cleaner production of flucytosine, a drug used in conjunction with other HIV treatments to reduce the mortality of HIV patients. The project is also working on more efficient screening methods and educational resources to improve pharmaceutical production.

Thank you for your attention!