



# High Quality Vaccine Production

with GEA Technology



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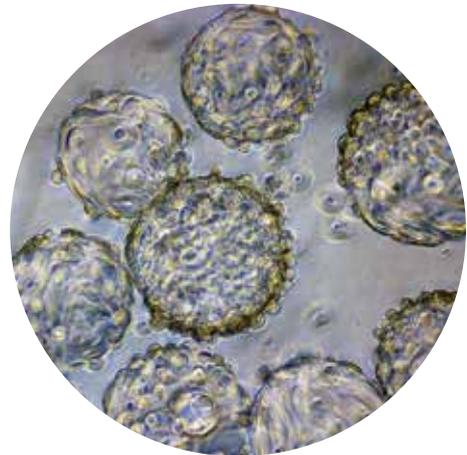
## Why GEA?

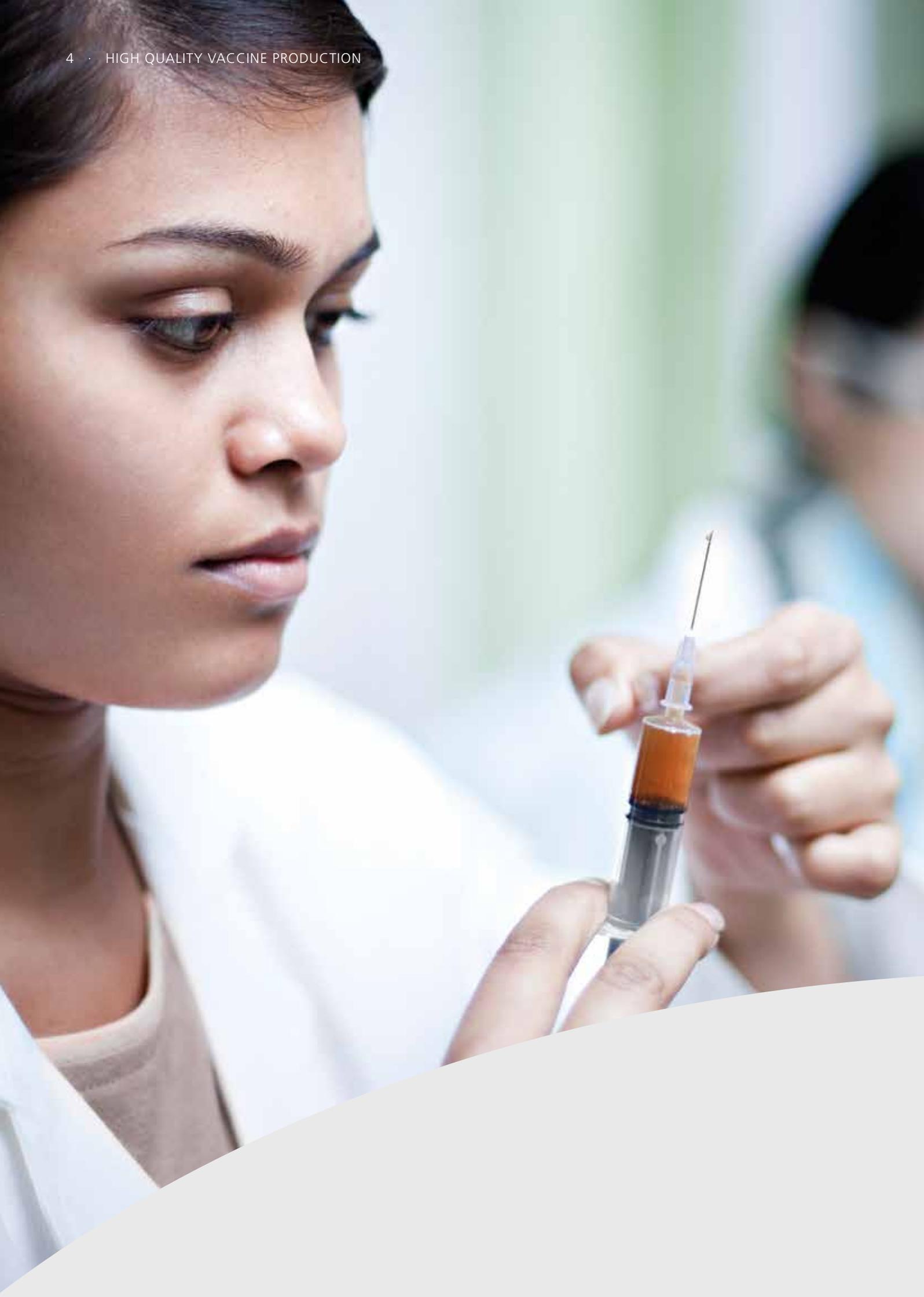
Pharmaceutical biotechnology requirements are high, including aseptic process management, optimum cleaning capability, closed product handling, compliance with GMP requirements, gentle product treatment, the efficient recovery of active ingredients and reliable scale-up. With technology and equipment designed specifically for this sector, GEA stands for total compliance with these requirements.

A critical factor underlying the success of the company is its ability to swiftly translate new developments into marketable processes and systems that fully meet the complex requirements of biotechnological procedures. With standalone machines or package units that guarantee a high yield of valuable substances and operate trouble-free, efficiently, reliably and economically throughout a long service life, GEA has developed numerous innovative improvements to vaccine production processes and brought them to the global market by applying first-class engineering.

With access to some of the world's most advanced manufacturing equipment and a wealth of expertise and experience to call on, GEA fundamentally understands the processes involved in vaccine production, the capabilities of the technologies employed and the engineering required to ensure that they operate at optimum capacity with the lowest maintenance.

From the planning phase up to the construction and automation of turnkey plants and process lines, which conform to stringent hygienic and regulatory requirements, GEA is dedicated to developing and finding customer-orientated solutions.





# Saving Lives with Affordable, Accessible Vaccines

As system integrators and liquid processing specialists, GEA has the scale, the know-how and the flexibility required to meet your specific application requirements. Whether large or small, GEA can add value to any vaccine production project.

Vaccines are among the 20th century's most successful and cost-effective public health tools to prevent disease, disability and death. Not only do they prevent a vaccinated individual from developing a potentially serious disease, vaccines routinely recommended for children also help to protect entire communities by reducing the spread of infectious agents.

Immunisations have eradicated smallpox, eliminated poliomyelitis in the Americas, and controlled measles, rubella, tetanus, diphtheria, *Haemophilus influenzae* type b and other infectious diseases. These are tremendous accomplishments but more remains to be done; promoting optimal health through the administration of safe and effective vaccines will continue to be a priority for the biopharmaceutical industry.

A vaccine is a biological preparation that improves immunity to a particular disease. A vaccine typically contains an agent that resembles a disease-causing micro-organism and is often made from weakened or killed forms of the microbe, its toxins or one of its surface proteins. This antigenic material stimulates the body's immune system to recognize the agent as a foreign body, destroy it and "remember" it, so that the individual's immune system develops adaptive immunity to a specific pathogen and can more easily recognize and destroy any of these micro-organisms that it encounters at a later date.

## VACCINATION SAVES LIVES

More than 3 million lives are saved, every year, thanks to a vast range of vaccines that provide protection from more than 26 infectious diseases.

# Working Together to Save Lives

The World Health Organization projects that the global vaccine market could be worth \$100 billion by 2025, but there is a huge volume and value divide between the high-income countries of the developed world, and the low-to-middle income countries of the developing world. High-income countries account for approximately 82% of global vaccine sales — but only 20% of the annual volume of vaccines used worldwide.

Top tier manufacturers command premium prices for vaccines developed using the latest technologies, which may offer benefits such as fewer side-effects. These vaccines are marketed in high-income countries that can afford them. A second tier of high volume, lower cost manufacturers includes more than 50 producers in Latin America, the Middle East and Africa and Asia Pacific, who are members of the Developing Countries Vaccine Manufacturers Network (DCVMN) alliance. The DCVMN producers aim to provide a sustainable supply of quality, affordable vaccines to the developing world.

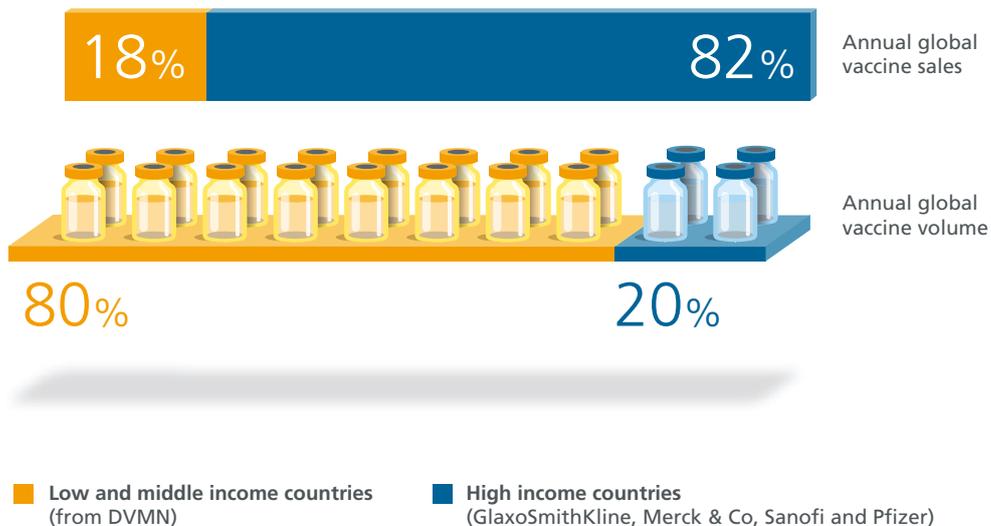
Agencies such as UNICEF and PAHO (Pan American Health Organization) purchase bulk vaccines from DVMN manufacturers on behalf of low- and middle-income countries,

which account for approximately 18% of annual global vaccine sales and 80% of the number of doses sold globally every year.

UNICEF supplies vaccines for 45% of the world’s children aged 5 or younger and, in 2016, secured 2.56 billion doses of vaccines for distribution in 95 countries. The availability of low cost, safe and effective vaccines is critical to ensure that populations in the poorest nations have access to life-saving preventive medicines.

GEA understands that producers in emerging markets may not have access to safe, high quality plant. We partner with these manufacturers to supply key process, technology and engineering expertise to facilitate vaccine production, and supply critical equipment for separation, freeze drying, fermentation and/or cell rupture.

Our equipment ensures that manufacturers in developing nations can construct WHO-approved vaccine manufacturing facilities in their own countries, providing millions of doses of vaccines for local populations. Home-grown vaccine production reduces costs, improves logistic and cold chain requirements, and is more environmentally friendly.





## GLOBAL VACCINE MARKET: RAPID GROWTH AND CHANGING STATUS

- Tripled in value from \$5 billion in 2000 to \$24 billion in 2013
  - Global market projected to rise to \$100 billion by 2025
- More than 120 new products in the development pipeline
  - 60 are of importance for developing countries
- Vaccines are becoming a driver for the pharmaceutical industry.

# Animal Vaccines

The major goals of veterinary vaccines are to improve the health and welfare of companion animals, increase the production of livestock in a cost-effective manner and prevent animal-to-human transmission from both wild and domestic animals.

The global veterinary vaccines market is expected to reach a value of \$12.6 billion by 2025 and has emerged to become a significant investment option for both government and non-government players. A rise in the number of pet owners and their shifting focus towards healthy animal practices, as well as the bulk purchase and supply of vaccines by countries with large livestock populations, are some of the factors propelling the growth of the market.

Furthermore, advances in formulations and the commercialization of products that can be administered orally are escalating the adoption of vaccines for wild as well as domestic animals. Other drivers include the growth of herd populations and repeated breakouts of livestock diseases, the increasing adoption of companion animals, the rising incidence of zoonotic diseases, initiatives by various government agencies, animal associations and leading players to improve animal health and the introduction of new types of vaccines (DNA, monoclonal antibodies, etc.).

North America still dominates the animal vaccine market, with the Asia-Pacific region projected to witness swift growth owing to the speedy adoption of veterinary vaccines for quality food products and better animal health. The companion animal segment is a fast-growing segment, whereas cattle vaccines still represent the largest share of the market. From a production standpoint, attenuated vaccines have become increasingly popular as a result of benefits such as improved effectivity and enhanced long-term prevention.

GEA is also combining its knowhow in formulation technologies, freeze- and spray drying work with the expertise of vaccine developers and manufacturers to help develop new processes for animal vaccine manufacture and formulation. Our spray-drying and freeze-drying technologies are helping innovative technology companies to develop temperature-stable vaccine preparations that have a long shelf-life without the need for refrigeration, and which can be transported more easily to challenging and remote areas.





GEA SUPPORTS SOME OF THE BIGGEST  
MULTINATIONAL VACCINE COMPANIES WITH  
THE DESIGN AND INSTALLATION OF NEW  
FACILITIES, EXPANSIONS AND UPGRADES.

# Vaccine Production

When a suitable host strain for antigen has been chosen, it is isolated in ampoules and stored at  $-192\text{ }^{\circ}\text{C}$  in liquid nitrogen. Production commences with the growth of a feed culture in a pre-fermenter that is then transferred to the main fermenter. The fermentation process is supplemented by a nutrient solution: nutrients are dissolved in a nutrient tank and added to the fermentation process after filtration. The cells are then separated from the clear phase by centrifugation. The active is then isolated and purified by suitable downstream processing. The raw vaccine passes into the mixing vessel where their immunogenicity is increased by the addition of adjuvants, stabilisers and preservatives.

## The Vaccine Development Cycle

Vaccine research is long, complex and costly. Because a vaccine is a biological product made from living micro-organisms, its development cycle is quite different from that of a pharmaceutical product:

**Exploratory stage:** to understand the disease, its epidemiological data and the right proteins (antigens) to use in preventing or treating the disease

**Preclinical stage:** to assess antigen safety and select the best candidate vaccine

**Clinical development:** a dozen (Phase I) to a thousand people (Phase III) are involved in clinical trials and the first batches are produced (clinical batches and industrial batches for compliance)

**Regulatory approval:** all the data collected through the preceding stages are submitted to the relevant health authorities for approval

**Manufacturing process:** takes up to several months to produce a single batch of vaccine

**Quality control:** approximately 70% of production time is dedicated to quality control and pharmacovigilance procedures in the clinical development and production phases.

## Live vaccines

With live vaccine therapies, attenuated strains (bacteria or virus) or a causative agent that's closely related to a pathogen are, by definition, antigens, but lack the pathogenic effects. They are bred from less-pathogenic mutations of virulent micro-organisms, which are suitable for the production of vaccines or their ability to cause disease is removed, either by growing them in a certain way or by using physical or chemical treatments. Examples of live vaccines include measles, mumps, rubella, yellow fever, chickenpox, tuberculosis, human rotaviruses and whooping cough (pertussis).

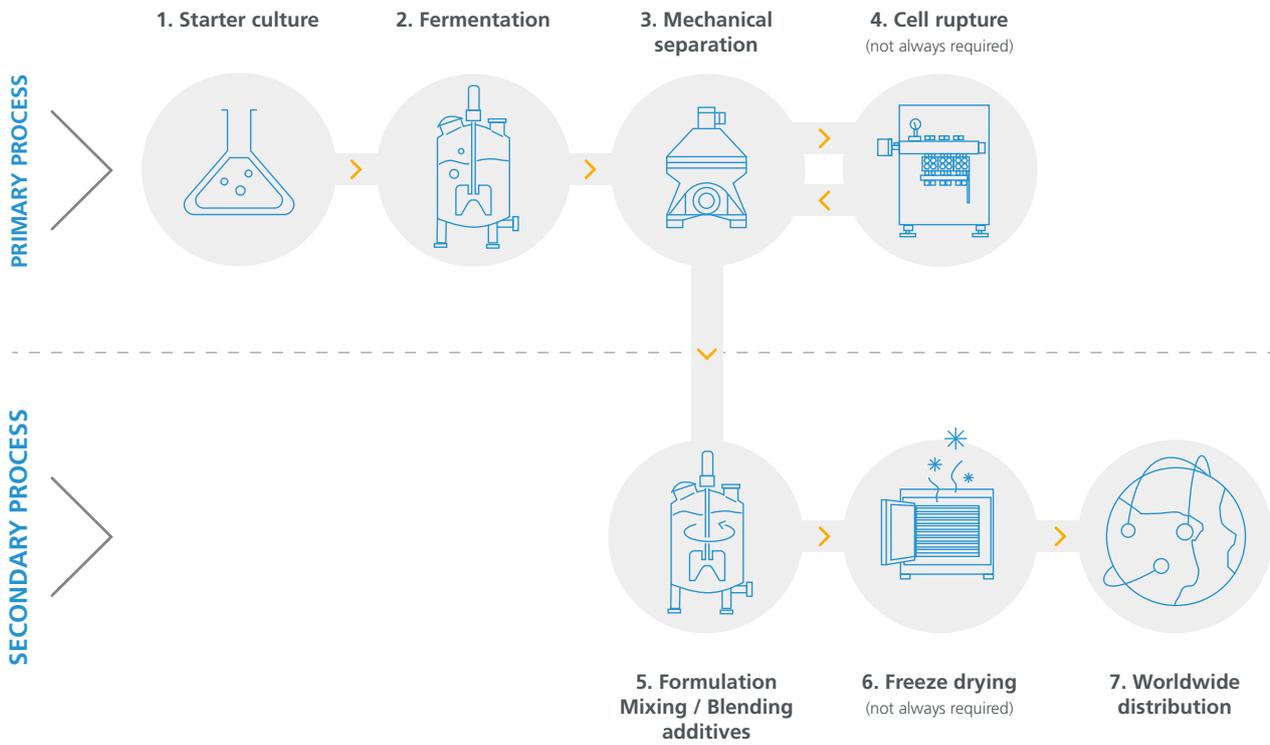
## Non-live vaccines

Non-live vaccines include influenza, cholera, bubonic plague, hepatitis A and B, tetanus and diphtheria, among others. Inactivated vaccines can be produced from the whole micro-organism/virus or just parts of it. Whole germ vaccines are made from the entire pathogenic agent, which is killed using chemicals or heat, without altering its immunogenicity. Subunit vaccines only comprise those parts of the infectious agent necessary to obtain an immune response (antigens).

## Recombinant Vaccines

Recombinant vaccines are produced by genetic engineering. Other animal cells or yeasts can be used as 'antigen factories,' producing large amounts of vaccine antigen, which is then used to produce an immune response.

Example process line for the production of live vaccines.



# Fermentation

GEA is the worldwide specialist in the manufacture of fermentation systems for the pharmaceutical and biotech industries. We have a solution for all your bioprocessing/fermentation needs because we understand bioreactors and the processes required to manufacture pharmaceuticals according to strict cGMP, FDA and EMA guidelines.

All vaccines, whether live (bacteria or viruses), inactivated (bacteria and viruses), toxoids or antigens, are produced using fermentation technology in fermenters, bioreactors or, in some examples, even hen's eggs. Apart from eggs, GEA is a marketleading supplier of complete fermentation systems for bacteria, yeast, mammalian cells and viruses, such as anaerobic tetanus fermenters with vibrating stirring systems in sizes up to 1000 L, aerobic fermenters for pertussis fermentation with special stirrers and mechanical foam breakers, equipment for yeast fermentation and for the state-of-the-art production of antigens such as Hepatitis B Antigen (HBsAg).

These production lines can be complemented with supplementary tanks for media preparation and harvesting, for example, and further enhanced by integrating downstream process equipment such as cell and product separators, homogenizers for cell disruption and/or filtration units for microfiltration and ultrafiltration. Additional steps including sedimentation and decanting/filtration can also be done with our specialised products.

Cell culture systems for virus-based production of polio vaccines, requiring the microcarrier-based cultivation of adherent cells, are also available, including cell culture systems for submerged fermentation for foot and mouth disease (FMD). The integration of special separators and filter systems enables cell debris removal and chemical-based virus inactivation and further purification steps such as chromatography are managed by integrating equipment from third-party suppliers.



The final step in vaccine production is formulation, which is also in GEA's scope of supply (see Media Preparation and Formulation), as are biological inactivation systems for waste and effluent treatment.

GEA is a single-source supplier of modular systems and solutions to meet the needs of any pharmaceutical, microbial or cell fermentation process. The company has the expertise and industry knowledge to help customers test processes and make the right choice of equipment to ensure security of outcome and the fastest time to market. All vessels can be supplied as standalone equipment or as automated process units delivered as fully functional modules, installed on site, including agitators, homogenizers, metering and regulating technology, control units, valves and pipe connections. Options for hazardous environments are also available.

## Quality Credentials

- cGMP/FDA/EMA
- Manufactured as per PED (Pressure Equipment Directive)
- ASME U-Stamp
- China Manufacture License (SELO)
- Quality plan and materials tracing
- Own non-destructive testing
- Weld seam documentation
- Qualification (IQ/OQ)
- Quality Management System according to DIN EN ISO 9001.

## PERTUSSIS FERMENTATION SYSTEM FOR TIANTAN BIO

In January 2010, GEA received an enquiry from Beijing Tiantan Biological Products Co. Ltd (Tiantan Bio) to supply a fermentation system.

Tiantan Bio operates as a subsidiary of the National Vaccine and Serum Institute (NCSI), China's premier research and manufacturing organisation for biological products. The company is primarily engaged in the research, development and production of bacterial and viral vaccines, blood derivatives, diagnostic reagents and various kinds of biopharmaceutical products.

Having initially contacted GEA Process Engineering China (GPCN), the request was forwarded to GEA; and, as a result of a close collaboration between the three companies during the following months, including several visits China by GEA specialists, a quote was prepared that resulted in Tiantan Bio ordering a fermentation system from GEA in Germany.

In May 2010, detail engineering work began: the system comprises two seed fermenters with volumes of 50 L and 500 L, two 5000 L production fermenters and a CIP-system to clean all the required equipment. A two-level platform was installed around the 500 and 5000 L fermentation skids to provide full component access, and visualisation screens were provided for the operators and maintenance staff.

All the fermenter vessels were designed, manufactured and inspected in the GEA workshops in Hildesheim, Germany, to comply with Chinese pressure vessel regulations. Each fermenter was equipped with an agitator and a heating and cooling system, as well as the connections required to add liquid and gaseous media, which are needed for pertussis cultivation. All media addition steps are measured and controlled by the fully automated process system, as are all the relevant process and quality values.



# Mechanical Separation

GEA has been instrumental in advancing mechanical separation technology. Providing solutions in areas such as enzymes, hormones, human blood proteins, mammalian cell culture, pharmaceutical proteins, starter cultures and vaccines, the company's technology plays a key role in the recovery of APIs and optimizing production processes and products.

Centrifugal separation is a vital part of vaccine production. Processing valuable cellular components in a reliable, smooth and efficient way is an economic driver whereas safe and superior hygienic processing is a technological one. Combined, they offer excellence, innovation and efficiency – the core features of all our products.

**Excellence in hygienic design:** With chemical CIP (clean-in-place) solutions, opening or dismantling individual machines has become obsolete. Good machine design is essential, including efficient draining, no dead spaces, smooth surfaces and optimum product-contact surface wetting during CIP.

**Excellence in processing:** Our SIP (sterilize-in-place) technology optimizes process efficiency and flexibility. It also prevents the release of toxic bacteria/micro-organisms, protecting both operators and the environment.

**Excellence in efficiency:** Invented and patented by GEA, the hydrohermetic feed treats the product in a gentle way with minimal shear forces. As a result, the viability and activity of proteins is significantly improved, with a concurrent increase in process efficiency.

Our centrifugal separators are designed especially for liquid-based applications. Using centrifugal force, they separate substances and solids from liquids. They are equally as effective at separating liquid mixtures at the same time as removing solids.

GEA offers an extensive selection of separators for biotechnology with varying production capacities and designs.



### One machine – up to three bowls

The new GEA flexChange Concept for pharma centrifuges is the world's first three-in one centrifuge concept for pharma and biotech applications, offering superior flexibility to meet changing demands and conditions.

The entire concept and its components are certified according to ASME BPE 2014.

### Our separator designs include

- self-cleaning disk separators also available in steam sterilizable design as an option
- self-cleaning disk separators for clarification and separating processes
- nozzle separators for the concentration and washing of suspensions.

### Key Features

- Gentle product feed with a hydrohermetic inlet
- Gentle discharge of solids
- Extremely fast, precise and flexible ejection
- Precisely metered discharge volumes
- Securely sterile and clean



# High Pressure Homogenization

GEA is the global technology and market leader for high-pressure pumps and homogenizers. In biotechnology and pharmaceutical industries, the cell rupture process plays a critical stage. Although some substances are produced by cells or released by autolysis, the preparation of many others – including vaccines, therapeutics, diagnostics and enzymatic preparations – require cell breakage to release the intracellular or subcellular material. As the majority of vaccines are prepared for injection or intravenous administration (as W/O formulations with inactivated bacteria), particle size is critical. A successful vaccine preparation requires a mean particle size 250–500 nm, with all particles measuring less than one micron.

Micronization involves reducing the particle size of liquid pharmaceutical products using dynamic high-pressure homogenization to make a dispersion of active ingredients more stable for enhanced clinical effectiveness. Optimized particle micronization and homogenous distribution means that API bioavailability and drug tolerance is improved.

The homogenization process is a mechanical one, achieved in one or more passes by forcing product through a homogenizing valve at pressures of 800–1500 bar. Within the valve, as a result of compression, acceleration, etc., the oil droplets are shattered and the suspended solid and semisolid particles are dispersed, stabilizing the emulsion and providing the levels of micronization required by the vaccine industry. GEA homogenizers are fitted with specifically designed high efficiency valves for optimized cell disruption that operate at the lowest possible pressure and recirculate material in a safe and cost-effective manner, with less product being discarded.

High-pressure homogenization is widely used in cell rupture applications to extract intracellular compounds without using solvents or other chemicals to break the cell wall. Being very effective and efficient, the homogenizers can often maximize the yield from valuable source material while keeping product quality at a very high level. GEA homogenizers are fitted with specifically designed high efficiency valves for optimised cell disruption in a single pass at the lowest possible pressure; designed in compliance with FDA and cGMP guidelines, they come with a full documentation package including materials certification (FDA-approved gaskets and 3A certification) and traceability, FAT/SAT procedures and IQ/OQ support.

## High Pressure Homogenization enables

- Particle size reduction down to nanometer range for injectable drugs
- Optimized use of emulsifiers and stabilisers
- Control and repeatability of results with no biological risk
- Solvent and chemical-free intracellular compound extraction to break the cell wall
- Effective and efficient process to maximize yield and maintain product quality
- Designed in compliance with FDA and cGMP guidelines



### Membrane Filtration

Membrane filtration offers tremendous separation and purification opportunities to the pharmaceutical and biotechnology industries, resulting in significant advancements in both product development and quality. GEA specializes in cross-flow membrane filtration — microfiltration, ultrafiltration, nanofiltration — and reverse osmosis.

Along with our process experience, we offer a wide range of both polymeric and inorganic membrane systems to provide the best possible solutions to our customers in the biotechnology industry. Membrane filtration for cell harvesting or biomass recovery is an important step in any fermentation process, especially when manufacturing bulk intermediates such as antibiotics.

Membrane filtration can successfully replace separation methods such as rotary vacuum filters or centrifugation in many facilities by significantly improving product yields and reducing operator involvement and maintenance costs. Membranes are also a standard part of industrial enzyme manufacturing lines to concentrate the enzymes prior to further downstream processing.

### Flow Components

From components to equipment and complete process lines, GEA offers a wide range of liquid handling solutions for use in pharmaceutical production plants. Our scope of supply includes raw material handling, mixing and blending, storage, end-of-line packaging, product recovery, cleaning and sterilizing in place, and automation.

And, from basic engineering, through detail engineering and design, construction, installation and commissioning, we can provide a comprehensive range that includes valve technology for all hygienic classes (Hygienic, UltraClean, Aseptic), hygienic pumps and cleaning technology.

Our components are designed to meet the highest requirements and can be readily combined with our standardized modular plant. Contact us today for more information about pumps, valves, cleaners, inline process connections, tank safety systems and expansion compensators.



# Media Preparation and Formulation

GEA supplies numerous different mixing and formulation systems, including standard systems as well as custom designed systems for media preparation and formulation.

For companies with frequent product changes or products that have to be prepared using dry substances and ingredients out of small vessels (bags, bottles etc.), batch mixing plant will provide the ideal solution. All ingredients are added at a single point, from a platform at a convenient working height. If required, the mixture from the starter vessel can be filtered en route to the blending tank.

The plant control system ensures that specific quantities from each line are conveyed to the mixing tank in accordance with the stored recipe information. Parallel material flows enable inline pre-mixing, thus reducing the time required in the mixing tanks.

Automation is achieved using PLC or DCS systems, which can also be incorporated into appropriate SCADA or MES systems as well.



# Aseptic Spray Drying

Spray drying offers many ways to design the particle characteristics desired. Forget the myth that heat sensitive materials are damaged, rather the opposite; spray drying is unique in turning a liquid into particles in just a few seconds.

For expensive sterile drugs, shelf-life is of the essence. The traditional way to convert a sterile liquid into a stable solid form is freeze drying; but, now, there's an alternative. Spray drying is a simple process in which droplets are dried to particles while suspended in a drying gas. This turns a liquid formulation into a dry powder in a single, continuous process. Spray drying is a continuous, scalable and well-proven technology, with plant capacities from 10s of grams to well beyond 10s of kilograms per hour.

As an example GEA and Cambridge Biostability Limited (CBL) collaborated to develop a revolutionary method of stabilising vaccines using spray drying. The process involves mixing the active ingredient with a water-soluble glass-like material, which is then dried into highly polished solid or hollow glass spheres of 3–20  $\mu\text{m}$  diameter. The spheres, containing the stable API, are then suspended in an inert anhydrous syrup, providing a thermostable, ready-to-inject liquid that can be stored and transported at ambient temperature.



# Freeze Drying/Lyophilization

GEA is one of the market leaders in pharmaceutical freeze drying/lyophilization and automatic loading and unloading systems. With more than 60 years of development, engineering and manufacturing experience and a pedigree of more than 1000 freeze dryer installations worldwide, GEA is a reliable supplier of high quality aseptic production solutions.

ISO 9001 certified and fully compliant with cGMP, GAMP and other relevant guidelines, GEA supplies a comprehensive range of products and services, comprising laboratory freeze dryers for pilot scale, R&D and small production batches, industrial freeze dryers and complete freeze dryer systems. These include, vial conveyer systems, Automatic Loading and Unloading Systems (ALUS™), integrated isolators and CIP skids with integrated freeze dryers.

## GEA Lyophil LYOPLUS™

Multi-purpose measurement for pharmaceutical freeze dryers

- Online measurement of moisture content
- Detects minute traces of silicone oil
- Fast and reliable chamber leak test

Our expertise includes innovations in shelf, chamber, slot door and condenser design, novel technology to avoid sticking stoppers, minimise footprint and energy usage, VHPT™ sterilisation technology to save costs and reduce cycle times, and a fast-track approach to full project execution – from signed contract to SAT in less than 9 months. GEA offers a complete programme of high quality products associated with all aspects of aseptic manufacturing and integrated solutions, in addition to efficient service for the pharmaceutical, healthcare and biotech industries.



### LYOSPARK® Nucleation Technology

LYOSPARK® controlled nucleation technology from GEA facilitates uniform ice crystal formation in laboratory and production-scale freeze dryers with a minimum degree of supercooling. This is reflected in more consistent and larger ice crystal sizes with a more open product structure.

As a result, faster drying and reconstitution times can be achieved. In addition, LYOSPARK® ensures inter-batch homogeneity, improves process repeatability and enhances both the presentation and quality of the final product.

### LYOSENSE® Online Moisture Control

Based on multipoint NIR measurements, the LYOSENSE® online moisture sensor from GEA comprehensively and non-destructively evaluates freeze dried product cakes in real-time. This easy-to-install and use measuring device is a non-invasive solution to moisture control, enabling the effortless detection of residual moisture, glass particles, cake homogeneity and API concentration.

Fully GMP and 21 CFR Part 11 compliant, and supplied with IQ/OQ/PQ support, the LYOSENSE® needs no consumables and provides the following benefits: whole cake assessment; fast processing times (5 ms); and a simple operator interface.

### LYODATA® for Total Vial Traceability

In collaboration with SCHOTT and HEUFT, GEA has developed a vial traceability solution that will help the pharmaceutical industry to implement the EU's drug anticounterfeiting directive, safeguard the rights of trademark and patent holders and, ultimately, protect patients.

LYODATA® provides unique marking, clear identification and the consistent traceability of pharmaceutical primary packaging, making drug counterfeiting practically impossible. The system also offers continuous quality inspection, 100% line clearance and precise sampling.

Ensuring distinctive and unmistakable marking and the 100% traceability of pharmaceutical products in vials or containers by laser coding and code verification, the system also includes process and product monitoring data from primary packaging production, grading and freeze drying, right up to the final finished product.



# GEA Service – For your continued success

GEA Service partners with our pharma customers, supporting them throughout the entire lifecycle of their plant and equipment to ensure business success. To guarantee optimum performance and operational excellence, we provide a wide range of services to maintain and improve your plant and equipment.

## Getting you started: seamless support for instant productivity and performance

From installation onwards, our GEA Service teams will work with you to get the best out of your plant and equipment. As a supportive and committed partner for life, we start as we mean to go on.

We plan and build according to individual needs, sharing process knowledge, training staff and supporting operators to get you up and running and deliver a smooth, seamless and ongoing service for optimum performance and safety.

## Keeping it running: the cost-efficient way to ensure safety and reliability

Regular maintenance is not a cost, it's an investment. By implementing corrective and preventive maintenance techniques, we ensure high performance, availability and quality — as well as maximizing the lifecycle of your equipment or plant.

To ensure you benefit from continuous production and minimal downtime, we provide fast support and top quality spare parts, whenever and wherever they're needed.

## Constantly improving: sharing our knowledge to safeguard your investment

To meet your production requirements — today and tomorrow — GEA works with you to keep your equipment up to date and optimized.

We safeguard your investments by constantly looking ahead, by upgrading or modernizing equipment and enhancing processes to meet changing needs and new market demands. We are always working to increase production efficiency and ensure peak performance.

## Together with you: enduring commitment to you and your business

By integrating the latest automation and control solutions, we boost your output and efficiency, reduce waste and minimize both resource use and the need for manual intervention.

Our commitment to you and your business means investing in your objectives, your risks and your future success. We collaborate with you to provide ongoing systems audits and on-site support, and to generate improved performance through innovative new service models.

Saving lives with affordable,  
accessible vaccines



## WHY VACCINES?

Promoting optimal health through the administration of safe and effective vaccines continues to be a priority for GEA and the entire biopharmaceutical industry.



## We live our values.

Excellence • Passion • Integrity • Responsibility • GEA-versity

GEA is a global technology company with multi-billion euro sales operations in more than 50 countries. Founded in 1881 the company is one of the largest providers of innovative equipment and process technology. GEA is listed in the STOXX® Europe 600 Index. In addition, the company is included in selected MSCI Global Sustainability Indexes.

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