eppendorf

Change History

Best fit solutions for researching the next life saving vaccine

Best Fit Solutions for Vaccine Development

Today's vaccines must meet stringent quality standards and must be developed and manufactured quickly and cost-effectively. Eppendorf's best fit solutions with carefully selected tools are tailored to the individual needs of your vaccine development workflow. Let us support you to get your vaccine faster to market!

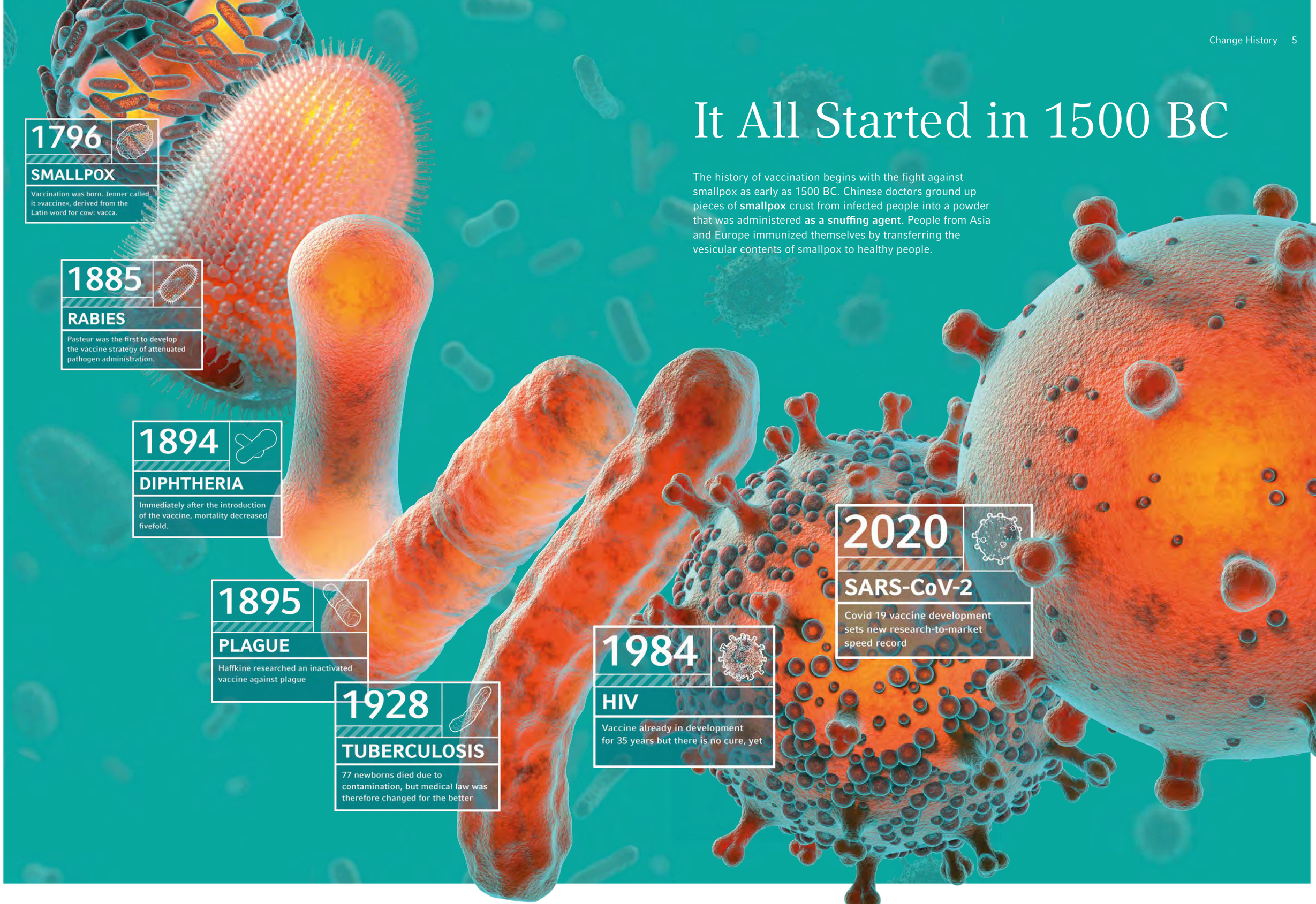
Your Benefits

> **Speed up & save time**
> **Rely on high-quality products**
> **Reproducibility across the entire workflow**
> **Use lab space efficiently**
> **Ease documentation**
> **Easy-to-use devices**

Index

It All Started in 1500 BC

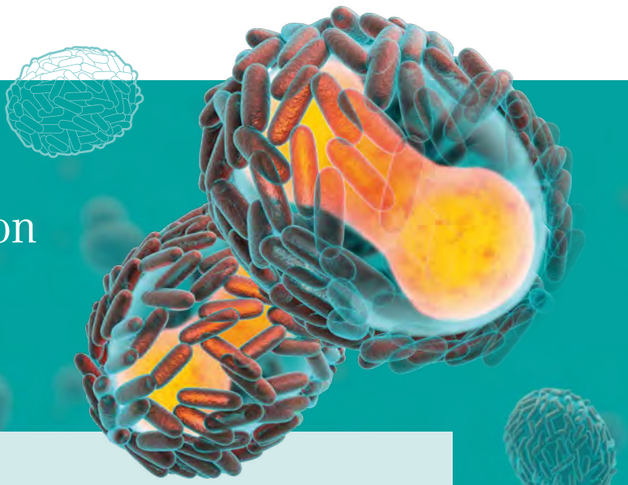
The history of vaccination begins with the fight against smallpox as early as 1500 BC. Chinese doctors ground up pieces of **smallpox** crust from infected people into a powder that was administered **as a snuffing agent**. People from Asia and Europe immunized themselves by transferring the vesicular contents of smallpox to healthy people.



Vaccine Development – Challenge & Chance From the Start

»The deviation of man from the stage in which he was originally placed by nature seems to have proved to him a prolific source of diseases. From the love of splendor, from the indulgences of luxury, and from this fondness for amusement he has familiarized himself with a great number of animals, which may not originally have been intended for his associates.
The wolf, now disarmed of ferocity, is now pillowed in the lady's lap. The cat, the little tiger of our island, whose natural home is the forest, is equally domesticated and caressed. The cow, the hog, the sheep, and the horse, are all, for a variety of purposes, brought under his care and dominion.«

Edward Jenner, Vaccination against Smallpox, 1798



Smallpox
The Birth of Vaccination

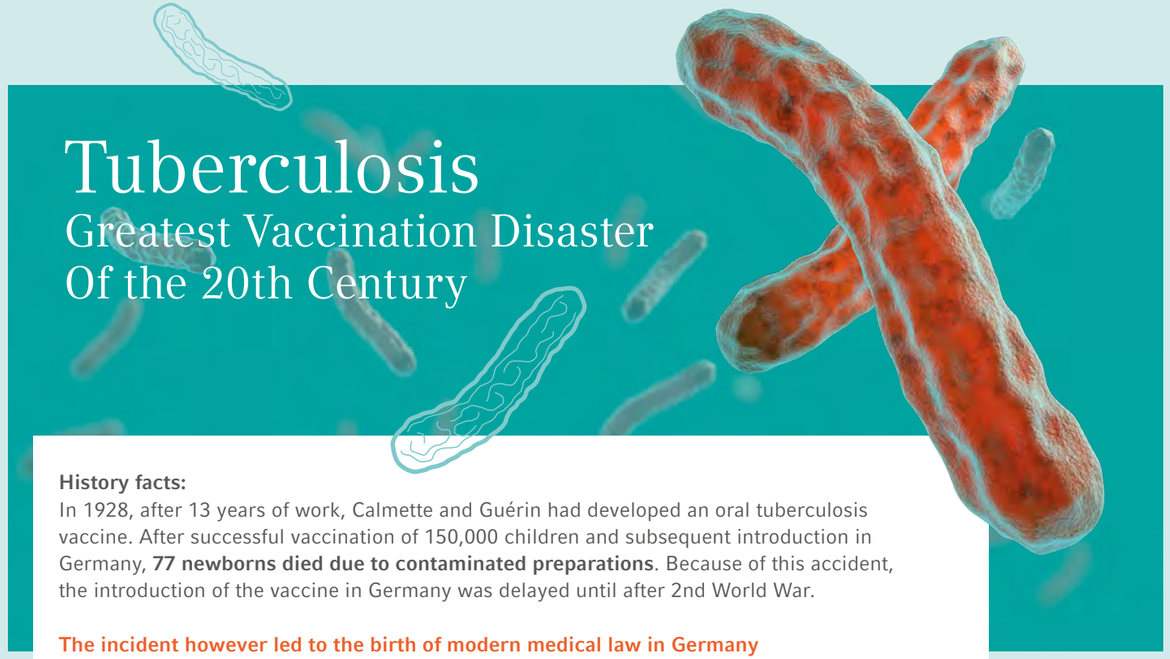
History facts:
In 1796, after recognizing that cowpox-infected farm workers were immune to human smallpox, Edward Jenner infected a boy by **scratching the pathogens under the skin**. After infection with the more dangerous human smallpox, the boy did not fall ill. Vaccination was born. Jenner called it »vaccine«, derived from the Latin word for cow: vacca.

Today smallpox has been eradicated by human effort and is a milestone in public health history.

Diphtheria
»Behring's Gold«

History facts:
In 1894, Behring discovered antitoxin-containing blood serum from infected animals as treatment against diphtheria, one of the most common causes of death among infants. **Immediately after the introduction mortality decreased fivefold.** Only 4 years passed to industrial production.

The antitoxin as immune serum is still used today and protects people all over the world from harm.

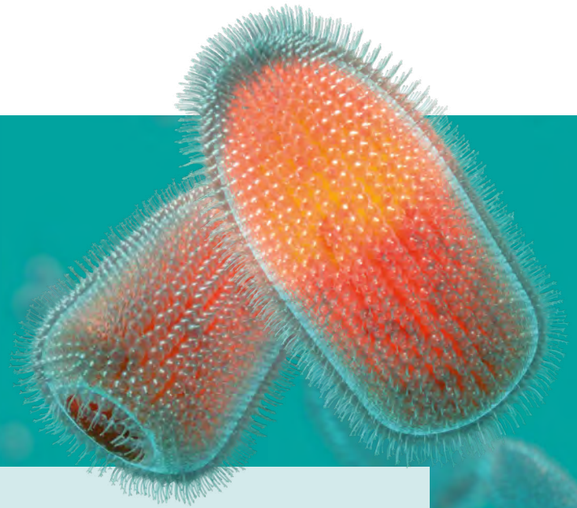


Tuberculosis
Greatest Vaccination Disaster Of the 20th Century

History facts:
In 1928, after 13 years of work, Calmette and Guérin had developed an oral tuberculosis vaccine. After successful vaccination of 150,000 children and subsequent introduction in Germany, **77 newborns died due to contaminated preparations**. Because of this accident, the introduction of the vaccine in Germany was delayed until after 2nd World War.

The incident however led to the birth of modern medical law in Germany

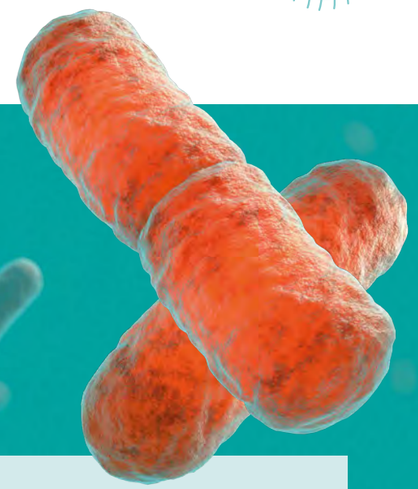
Rabies
A Daring Attempt



History facts:
Pasteur was the first to develop the vaccine strategy of attenuated pathogen administration in 1885. He treated a boy bitten by a rabid dog with an increasingly virulent suspension from an infected rabbit, which he simultaneously administered to a dog. **The dog died, the boy survived.** This success prompted the founding of the Pasteur Institute in 1887.

Today, there is an effective vaccine for both humans and animals.

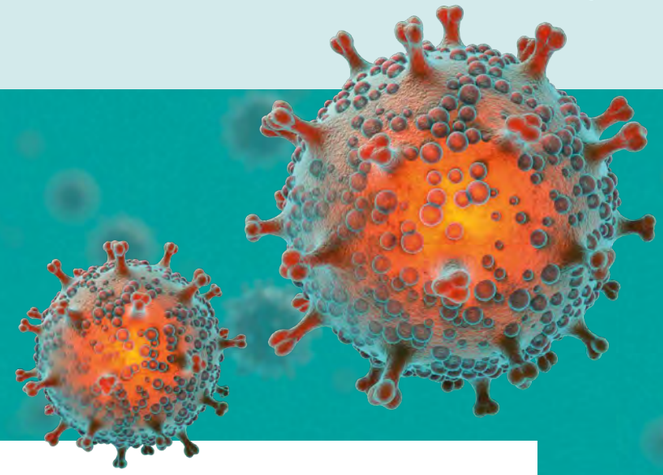
Plague
An Abrupt End



History facts:
Bacteriologist Haffkine researched an inactivated vaccine against plague. Various clinical trials were conducted in India and China with fluctuating results. In 1895, **contamination with tetanus spores caused all to die**, which had been vaccinated with the respective batch. This abruptly ended the use of the Haffkine vaccine.

While plague is still a dangerous disease, there are now improved diagnostic tools and effective treatment.

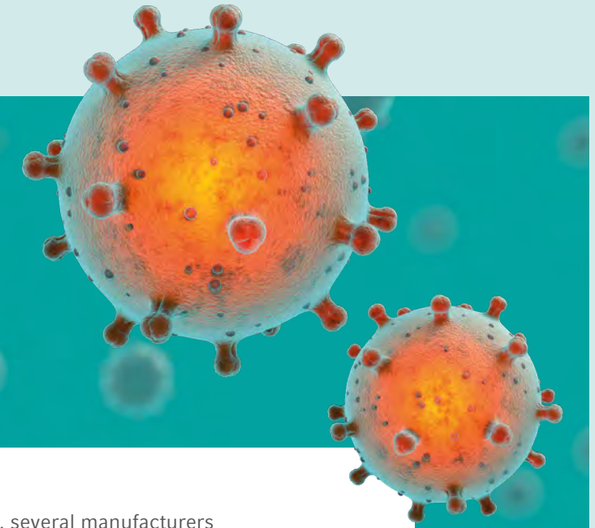
HIV
Just the Beginning



History facts:
When HIV discoverer Robert Gallo was asked after in 1984 when a vaccine would be available, he replied, »in two years«. In the meantime, **more than 35 years have passed**. HIV is a master at sidestepping and hijacking the immune response, its variability and immune evasion strategies are fundamental challenges in vaccine development.

Even though a vaccine is still being developed, HIV is now a manageable chronic condition.

SARS-CoV-2
Speed Record Holder



History facts:
In less than one year after the outbreak of the pandemic, several manufacturers have developed and licensed Covid-19 vaccines, setting an **all-time speed record from research to market maturity**. RNA vaccines against SARS-CoV-2 provide a disruptive technology that has advantages in terms of production and good immunogenicity.

Now, mRNA technology is a rapidly growing field with many exciting developments on the horizon.

Vaccine Technology Platforms

Numerous vaccine technology platforms evolved over the past decades. Today, addressing disease outbreaks and protecting the immuno-compromised population provides severe challenges and harbors significant growth potential. Traditional whole-pathogen vaccine platforms score with a proven track record for many diseases. While these vaccines still require cultivation of the pathogen, the newer generation such as recombinant protein and nucleic acid vaccines only require the genetic sequence of the pathogen. These breakthrough platforms can significantly accelerate development and manufacturing processes and unlock new potential for a broad range of indications at an unprecedented speed.

Traditional Vaccines

Inactivated vaccines
Inactivated vaccines (e.g., for hepatitis A, rabies, polio) still carry the full repertoire of immunogenic components of the original pathogen. Proper inactivation is mandatory to avoid viral reactivation and replication in the host.

+ Pathogen inactivation by radiation, heat, or chemical reagents ensures a superior safety profile and advantages in terms of transport and storage.

− Require processing of large quantities of the pathogen. The inactivation process can affect the antigen immunogenicity. As the antibody titers reduces over time, several booster doses are needed.

Live-attenuated vaccines
Repeated subculturing in a foreign host belongs to the most common methods to obtain attenuation of live-attenuated vaccines (e.g., for variola virus, measles virus, rotavirus). With each passage, the virus becomes less virulent. The native viral antigen conformation is still preserved, mimicking the natural infection without causing disease.

+ Usually produce long-lasting robust cellular and humoral immune responses with only one administration.

− Safety issues in immunosuppressed people may occur, weakened strains are difficult to obtain, development time is long, and refrigeration obligatory.

Strong Growing Vaccines

Protein subunit vaccines
Protein subunit vaccines (e.g., for influenza, hepatitis B and C) are a proven strategy for decades and still today in the spotlight for pandemic management.

+ Require no production of the whole pathogen because the vaccine consists of immunogenic viral or bacterial fragments generated by recombinant protein techniques. Since non-pathogenic, they are considered as safe. Multiple expression systems for antigenic protein components such as yeast, bacteria, insect, mammalian, and plant cells, allow the production of large quantities and to address unmet needs.

− Establishment of a proper scale-up of antigen production can be a major constraint. Several booster doses and adjuvants are needed.

Virus-like particle vaccines
Virus-like particle vaccines are self-assembled viral structural proteins that mimic the native virus. This feature enables to trigger strong immune responses.

+ Lacking the viral genome, the safety profile is excellent as the virus cannot replicate in the host. The production is scalable and safe as no living virus or inactivation steps are involved.

− The particle assembly is sometimes challenging, the manufacturing process complicated.

The Most Novel Vaccines

Nucleic acid vaccines
Nucleic acid vaccines are made up of mRNA or plasmid DNA encoding viral antigenic components to express specific proteins of a pathogen after injection. The technology of mRNA vaccines made its breakthrough with SARS-CoV-2. With dozens of potential applications including HIV, cancer, shingles, flu, cardiovascular applications, or Zika, It is a very promising technology.

+ Multiple advantages such as exceptionally fast modifiability in response to mutations, high versatility, high safety, and a fast, cost-efficient, and scalable production in a cell-free system. Vaccines for multiple indications can be produced using the same process.

− During vaccination the mRNA must be delivered directly into cells, which requires specific injection devices, electroporation, or a carrier molecule. mRNA vaccines exhibit instability and require a cold chain.

Improve Your Recombinant Protein Vaccine Discovery

Safe and consistent culturing of cells.
The **CellXpert® C170i** offers fast temperature and CO_2 recovery (< 5 min/s) and very stable environmental conditions for (e.g) virus host cells as well as reliable contamination prevention (e.g. 180 °C sterilization).

Speed up protein characterization assays.
The **Eppendorf Xplorer®** enables quick filling of plates using the dispensing mode. When connected to the **Pipette manager**, an even quicker operation of the pipette is possible.

Increase efficiency and downstream quality.
The **CR22N High Speed Centrifuge** with up to 58,700 × *g* speed enables the pelleting of small insoluble particles to assure the quality of downstream applications. Triangular bottles can speed up harvesting after protein-antigen expression.

1. Design of Antigen Expression Construct
2. Protein-Antigen Expression Optimization
3. Protein-Antigen Purification
4. Protein-Antigen Characterization
5. In Vitro & Vivo Screening
6. Process Development
7. Scaling Up

Protect your cells for protein-antigen production.
The New **Brunswick S41i Incubator Shaker** Design is ensuring minimum evaporation of media, stable conditions, and constant high humidity. Additionally, the high-temperature disinfection the seamless chamber design protect your cells during your initial R&D steps of overexpression optimization.

Maximize antigen retrieval.
The **LoBind®** material guarantees maximum sample retrieval for sensitive assays (e.g.) during protein-antigen characterization and lowest contamination risk. LoBind consumables are coating free and therefore, induce minimal risk of subsequent assay interference.

Automate your repetitive, routine tasks.
With the **epMotion®** you can use a variety of kits e.g. for plasmid isolation. The epMotion has an intuitive drag-and-drop-based software and full consumable flexibility.

Constant antigen expression conditions.
The **BioFlo® 320 Bioprocess Controller** offers an integrated Scale-up Assist software to facilitate uncomplicated and intuitive upscaling from R&D to production scale

* For research use only.
If you have any questions, please contact the Eppendorf Application Team.

Better mRNA Vaccine Development

Optimal transcription reaction conditions.
The **Eppendorf ThermoMixer®** allows easy and precisely controlled up-scaling of the in vitro transcription reactions for mRNA production. The optional **ThermoTop** further increases temperature homogeneity and prevents condensate formation.

Find the right conditions with fewer PCRs.
The in vitro transcription for mRNA vaccines requires the amplification of long, sometimes GC-rich DNA templates. With the **Mastercycler® X50** 2D gradient function, up to hundreds of PCR conditions can be checked in one run, saving you time and money.

Safe and consistent culturing of cells.
The **CellXpert® C170i** offers fast temperature and CO_2 recovery (< 5 min/s) and very stable environmental conditions for (e.g) virus host cells as well as reliable contamination prevention (e.g. 180 °C sterilization).

Speed up In Vitro screening assays.
The **Eppendorf Xplorer®** enables quick filling of plates using the dispensing mode. When connected to the **Pipette manager**, an even quicker operation of the pipette is possible.

1. Template design for In Vitro Transcription
2. Template Production in Bacteria/via PCR
3. mRNA Purification
4. mRNA Characterization
5. In Vitro & Vivo Screening
6. Process Development
7. Scaling Up

Smart and safe sample storage.
Safe Code Vials enable next level traceability when storing your mRNA at -80 °C. Get ID-specific consumable information for comprehensive documentation during your R&D phase. The ACT certified **CryoCube** freezers ensure energy efficiency and sample safety.

Maximize antigen retrieval.
The **LoBind®** material guarantees maximum retrieval of proteins and nucleic acids. This improves the reproducibility of sensitive assays, e.g. during antigen characterization. No coating further minimizes the risk of downstream assay interference.

Automate your repetitive, routine tasks.
With the **epMotion®** you can use a variety of kits e.g. for mRNA purification. The epMotion has an intuitive drag-and-drop-based software and full consumable flexibility.

Boost mRNA yield and quality.
The liquid-free control system of the **DASbox® Mini Bioreactor System** ensures fast and precise temperature control of mRNA synthesis reactions. The variable speed pumps of the DASbox ensure accurate addition of reaction components to increase the efficiency of mRNA synthesis.

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Improve the Development of Viral Inactivated / Attenuated Vaccines

Safe and consistent culturing of cells.
The **CellXpert® C170i** offers fast temperature and CO_2 recovery (< 5 min/s) and very stable environmental conditions for (e.g) virus host cells as well as reliable contamination prevention (e.g. 180 °C sterilization).

Thousands of PCRs in as little as 15 mins.
Large numbers of PCRs are required to amplify viral genomic information prior to sequencing. The **Mastercycler® X50** with the 384-well silver block can process hundreds of PCRs in as little as 40 min and with a fast polymerase kit even in less than 15 min. Connect up to 50 devices for increased throughput.

Ensure optimal assay performance.
Eppendorf Plates® LoBind® ensure maximum sample recovery during quantitative assays. They can be customized with barcodes for efficient sample tracking and are available printed with their LOT number.

Speed up virus characterization assays.
The **Eppendorf Xplorer®** enables quick filling of plates using the dispensing mode. When connected to the **Pipette manager**, an even quicker operation of the pipette is possible.

1. Host Cell Selection & Culture
2. Small Scale Virus Production
3. Inactivation / Attenuation
4. Virus Characterization
5. In Vitro & Vivo Screening
6. Process Development
7. Scaling Up

Ensure optimal assay performance.
The **LoBind®** material guarantees maximum sample retrieval for sensitive assays. It also demonstrates low virus binding activities. LoBind tubes are free of surface coating for lowest contamination risk.

Reproducible PBMC isolation.
The **5910 Ri centrifuge** has soft acceleration/break ramps to for optimized PBMC isolation during Ficoll gradient separation and reduced stress on sensitive immune cells used in immunology assays.

Automate your repetitive, routine tasks.
With the **epMotion®** you can use a variety of kits. The epMotion has an intuitive drag-and-drop-based software and full consumable flexibility.

Smart and safe sample storage.
Safe Code Vials enable next level traceability when storing your sample at -80 °C. Get ID-specific consumable information for comprehensive documentation during your R&D phase. The ACT certified **CryoCube** freezers ensure energy efficiency and sample safety.

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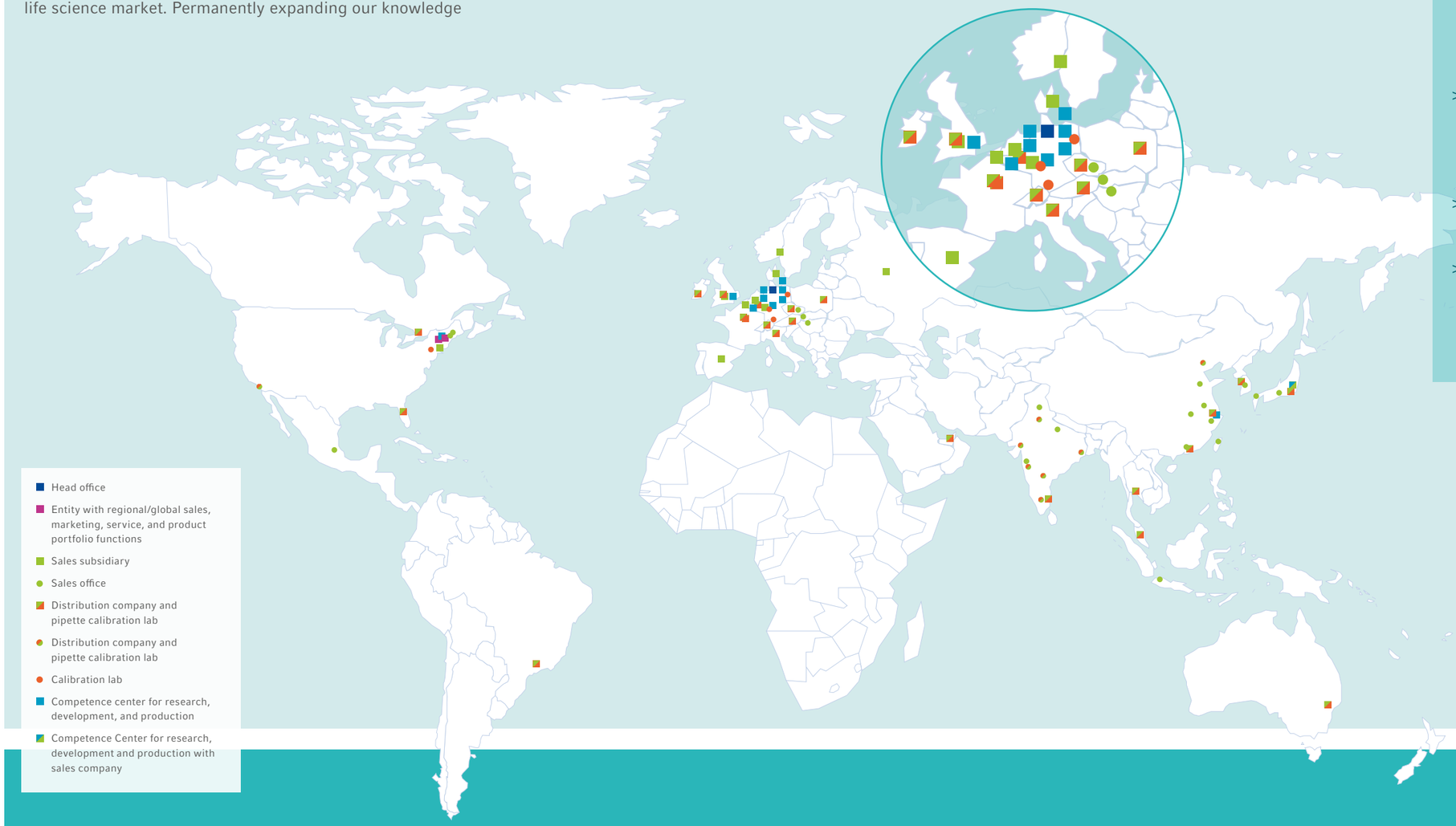
Best Fit Collaboration to Foster Innovation

For more than 75 years, Eppendorf supports customers in the areas of premium products, solutions, and services for customers around the world. Taking on the responsibility of our pioneer role we continuously develop our product portfolio to drive innovation in high-growth areas like the life science market. Permanently expanding our knowledge and expertise, learning from our customers and including customer feedback into product development are integral parts of our corporate philosophy.
We evolve with the needs of our customers to make you stay ahead in the market!



Rely on the innovative power of a global player and the approachability of a mid-sized company.

> **Innovation:** By permanently investing in our innovation pipeline, we ensure that all our products meet current and future market needs.

> **Sustainability:** Sustainability is the key driver of innovation. With Eco friendly instruments and solutions to reduce the impact on natural resources we empower customers to reach their sustainability goals.

> **Seamless supply chain:** To ensure a reliable supply around the globe with short delivery times we established stocks in proximity to our customers and continuously improve our logistic footprint.

> **Premium service:** Our lab sites around the globe provide 24/7 technical service and application support.

> **Quality:** Our products provide a reliable quality all over the world and are designed to deliver reproducible results every time and everywhere.

Two Minutes on...

Meet the People Behind the Scenes. Watch Our Video Interview Series That Covers Various Topics Close to Our Heart.

We are your strong partner for pharmaceutical research! Learn how we strive to improve people´s living conditions beyond life science products.

Linette Philip
Head of Portfolio Digital Solutions

Digitalization
Speeding up and improving innovation cycles

Ines Hartmann
Application Specialist Cell Handling

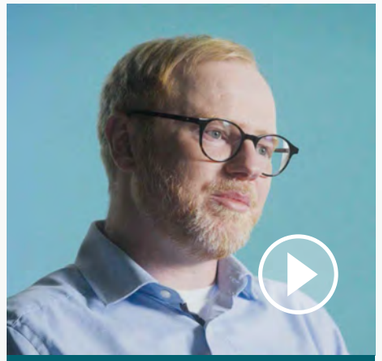
Customer Support
24/7 global expert support for international customers

Marlene Jentzsch
Head of Division Separation & Instrumentation

Quality
Products that help customers improving their daily life

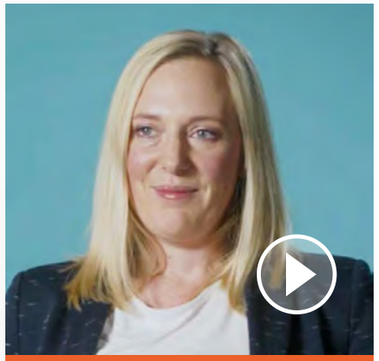
Dirk Pape
VP Global Supply Chain Management

Supply Chain
A seamless supply chain for short delivery times



Enrico Jacobi
Global Head of Sustainability & HSE

Sustainability
Reducing the impact on natural resources whenever it is possible



Katlin Heinemeyer
Product Innovation Manager

Innovation
Driving innovation to reflect sustainability trends

Supporting You – Maintenance and Qualification Services

With our basket of Service and Extended Warranty Agreement solutions we take the load off your shoulders by simplifying your ordering and budgeting process for various services over the full lifetime of your instruments. Your costs become reduced and predictable, thereby assuring continuous productivity and a long service life.

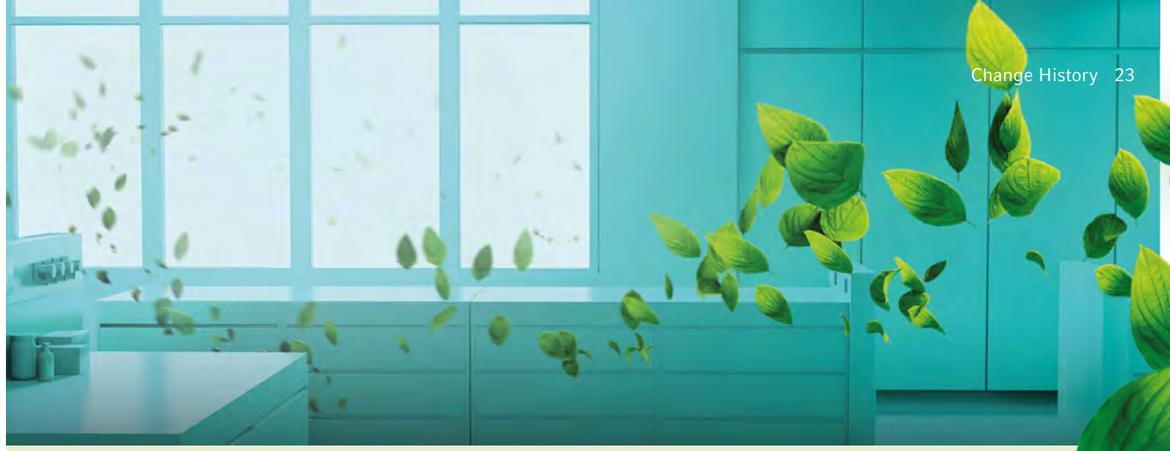
In addition, our agreements include repair costs – fully or partially – and discounts on other services. Benefit from assured premium performance for your peace of mind!

Installation Qualification and Operational Qualification services – GxP compliant
Are you working in a regulated environment? We now offer specifically created and revised Installation Qualification and Operational Qualification services including GxP compliant documentation. These documents support the complex GxP compliant standards and regulations reducing your administrative workload, and provide you with qualified assurance that your instrument is installed and operating in accordance with manufacturers' specifications.

Calibration and verification services
How do you know your experimental data is reliable? Assuring the precision and accuracy of your instrument is maintained according to specifications is your first step to reliable results.

Preventive Maintenance services
How much do you rely on keeping your instrument in good working order? Our professional cleaning and maintenance services are aimed at the prevention of unexpected downtimes and failures by early detection of problems. Keeping your instruments in perfect working order will not only extend their service life, but also increase your productivity.

For more information, service ordering details and contact form please visit:
www.eppendorf.com/epServices



Sustainability Can Only Be Achieved in Collaboration

The fundamental principle of sustainability has always played a role at our company since its founding in 1945. Within the Eppendorf Group, our goal is to continue to grow and develop so that we do not exceed the bounds of our planet's resilience now or in the future, and to ensure that our actions are aligned with society's needs.

To achieve sustainable business activities, we identified eight key sustainability topics along our value chain. They are divided across four key strategic issues that guide our actions and activities as a responsible company:

Climate Change:
> Reduce CO_2 emissions generated at our own production and administrative sites
> Reduce CO_2 emissions arising at the customers' end as a result of the use of our products

Natural resources:
> Prevent waste arising as a result of the use of our consumables
> Minimize waste arising as a result of our packaging
> Reuse and recycle resources and waste arising from our business activities

Social Compliance:
> Ensuring that our suppliers uphold fair labor conditions

Social Wellbeing:
> Promote the safety and health of our customers during the use of our products
> Ensure diversity and equality of opportunity at our sites and lifelong learning

Read our sustainability Report or visit us online to learn more:
www.eppendorf.com/sustainability

Take a Deep Dive Into the Vaccine Solutions at Eppendorf and Read Our Literature:

Application-Note 180:
Eppendorf LoBind®: Evaluation of Protein Recovery in Eppendorf Protein LoBind® Tubes and PlatesTubes

Application-Note 423:
Using the Mastercycler® X50 and Its 2D-Gradient to Increase Yield and Specificity of Your PCR

White-Paper 064:
Unique 4 × 1.5 L Capacity Rotor for High-Speed Centrifuges CR22N and CR30NX

Application-Note 255:
Hybridoma and CHO Cell Culture using the New Brunswick™ S41i, an Environmentally-Friendly, »Low Emission« Incubator Shaker

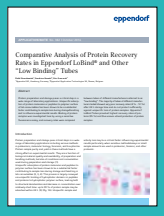
Application-Note 437:
Standardized and Water-free Cell Thawing using the Eppendorf ThermoMixer® C with the Eppendorf SmartBlock™ cryo thaw

White-Paper 065:
Digitalization in the Lab – Really a One-Way Towards More Sustainability

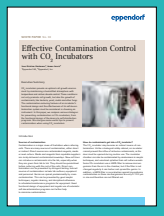
Application-Note 372:
Faster Isolation of PBMC Using Ficoll-Paque® Plus in the Eppendorf Multipurpose Benchtop Centrifuges 5920 R and 5910 Ri

Application-Note 446:
Breaking Barriers: Endpoint PCR in 15 Minutes or Less

White-Paper 071:
How Can I Improve Sustainability in My Lab?



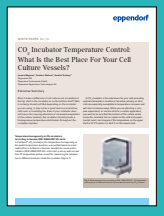
Application-Note 382:
Comparative Analysis of Protein Recovery Rates in Eppendorf LoBind® and Other »Low Binding« Tubes



White-Paper 030:
Effective Contamination Control with CO_2-Incubators

White-Paper 072:
Laboratory Waste – Immutable Fact of Life, or Opportunity for Change?

Application-Note 400:
Reduced PCR runtimes and increased yields using Eppendorf Fast PCR Consumables



White-Paper 056:
CO_2-Incubator Temperature Control: What is the Best Place for Your Cell Culture Vessels?

White-Paper 077:
How to Develop and Assemble a Sustainability ULT Freezers CryoCube?

References:
Kyriakidis, N.C., López-Cortés, A., González, E.V. et al. SARS-CoV-2 vaccines strategies: a comprehensive review of phase 3 candidates. npj Vaccines 6, 28 (2021). https://doi.org/10.1038/s41541-021-00292-w
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Li, YD., Chi, WY., Su, JH. et al. Coronavirus vaccine development: from SARS and MERS to COVID-19. J Biomed Sci 27, 104 (2020). https://doi.org/10.1186/s12929-020-00695-2

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