mRNA Tech Transfer-BioE status

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Components of lipid nanoparticles
- Cholesterol
- phospholipid
- ionizable lipid
- PEG-conjugated lipids

Lipid-based mRNA nanoparticle
## Bio E Vaccine Portfolio

<table>
<thead>
<tr>
<th>Toxoids</th>
<th>Polysaccharide Conjugates</th>
<th>Inactivated Bacteria</th>
<th>Inactivated Virus</th>
<th>Protein Sub-Unit</th>
<th>Live Attenuated Virus</th>
<th>Vector Based vaccine</th>
<th>mRNA based vaccines</th>
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<tbody>
<tr>
<td>Diptheria</td>
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<td>Pertussis</td>
<td>Japanese Encephalitis</td>
<td>Hepatitis B Ag</td>
<td>Measles</td>
<td>Ad26_Spike Protein</td>
<td>To be added</td>
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<td>Tetanus</td>
<td></td>
<td>Cholera</td>
<td>Polio (S19-strains)</td>
<td>RBD-SARS-CoV-2</td>
<td>Rubella</td>
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<td>Pertussis</td>
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<td>Pertussis antigens</td>
<td>Novel-Oral Polio-Type2</td>
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### Polysaccharide Conjugates
- H. Influenza b (PRP)
- Salmonella Typhi (Vi)
- Pneumococcal PS (14)
- Salmonella paratyphi (O2)
- Meningococcal PS (5)

### Inactivated Bacteria
- Pertussis
- Cholera

### Inactivated Virus
- Japanese Encephalitis
- Polio (S19-strains)

### Protein Sub-Unit
- Hepatitis B Ag
- RBD-SARS-CoV-2
- Pertussis antigens

### Live Attenuated Virus
- Measles
- Rubella
- Novel-Oral Polio-Type2

### Vector Based vaccine
- Ad26_Spike Protein

### mRNA based vaccines
- To be added

### Additional Vaccines
- TT & Td
- DTP & Liquid Pentavalent Vaccine
- Measles-Rubella
- Inactivated JE-Adult
- Inactivated JE-Infant/toddlers
- Typhoid Conjugate Vaccine
- Ad26S_Janssen Vaccine

### Hepatitis B Vaccine
- RBD-COVID19 vaccine
- Pneumococcal Conjugate Vaccine (PCV14)

### Additional Vaccines
- Inactivated Polio Vaccine; Hexavalent Vaccine
- nOPV2
- Bivalent Typhoid Conjugate Vaccine
- aP based vaccines
- Meningococcal Conjugate Vaccine

**Supplied > 3 Billion Vaccine Doses globally in last 5 yrs**

Manufactured in 10 DS suites and 8 B&F Lines

Additional 4 DS suites under qualification
Status of mRNA vaccine development

- Selected as mRNA Tech Transfer Spoke Partner in March’22
- Conducted in-person training of five member team at Afrigen in Sept’22
- Have established basic laboratory-scale process to produce plasmid-DNA and mRNA post IVT based on TT information and using suitable/available reagents
- Initially selected a commonly used reporter gene based protein for mRNA translation in \textit{in vitro} systems
- Demonstrated success in pDNA and stable mRNA production and transfection followed by consistent protein expression
- Selecting appropriate lipids for LNP preparation
Key Next steps

- Select the antigen for candidate vaccine to address unmet needs. Most likely non-COVID19

- Incorporate and adopt the mRNA vaccine technology from Afrigen-Biovac Hub to advance the candidate vaccine in development pathway

- Facility:
  - Selected mRNA-DS and DP facilities for clinical manufacturing from existing suites augmented with mRNA specific equipments identified at the Hub
  - Developed conceptual design for a large scale fully integrated mRNA vaccine facility (500 MDS+/yr) based on first generation technology. Design will evolve based on the ongoing work at Hub and overall mRNA ecosystem!
Challenges

❖ mRNA will be suitable for only few pathogens. Identifying the optimum target is crucial

❖ Need to improve the safety profile of current mRNA vaccines to enable LMIC deployment in routine immunization

❖ Develop mRNA vaccines suitable for infants/toddlers with appropriate safety/immunogenicity/persistence profile

❖ Address thermo-stability either via LNP/mRNA optimization or lyophilization

❖ Best way to establish/maintain mRNA technology for future pandemic response is via commercial vaccine manufacturing in resource-constrained LMIC setting
Thank You