**VIRUS-LIKE PARTICLES**

**Definition**
Protein structures that mimic the organization of native viruses but lack the viral genome, becoming potential vaccine candidates

**Types**
- Number of structural proteins: Simple or complex
- Presence of envelope: Enveloped or non-enveloped

**Vaccination role**
- Traditional vaccines: Low
- Inactivated vaccines: Medium
- Recombinant proteins: High
- Virus-like particles: Medium
- Peptide vaccines: Medium
- Live recombinant vaccines: High
- DNA vaccines: Low

<table>
<thead>
<tr>
<th>Safety</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Medium</th>
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<tbody>
<tr>
<td>Price</td>
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<td>Medium</td>
<td>Expensive</td>
<td>Cheap</td>
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<tr>
<td>Administration</td>
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<tr>
<td>Immunogenicity</td>
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<td>Low</td>
<td>High</td>
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<tr>
<td>Adjuvant</td>
<td>Yes</td>
<td>Depends</td>
<td>Yes</td>
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</table>

**Advantages and Disadvantages**

**Advantages**
- High versatility
- High complexity
- Promoters power
- Disulfide bond formation
- Post-translational modifications

**Disadvantages**
- Protein folding
- Glycosilation
- Proteolytic processing
- Contamination of baculovirus particles

**Solutions**
- Chaperones or foldases
- Genetic modification of insect cells/baculoviruses
- Proteolytic preservatives
- Diversity of downstream strategies

**ADVANTAGES AND DISADVANTAGES**

**The Present: Cervarix®**
- Recombinant vaccine against Human Papillomavirus
- Bivalent: Against HPV types 16 and 18
- Simple non-enveloped VLP composed by L1 protein
- Use of aluminum hydroxide adjuvant

**Achievements**
- The second VLP-based approved vaccine
- The first approved vaccine using BEVS

- Produced by GlaxoSmithKline
- Biologicals
- Approved by the FDA in 2009
- Data from 13 clinical studies involving 30,000 females were submitted in support of licensure

**ABBREVIATIONS**
- VLP: Virus-Like Particle
- BEVS: Baculovirus-insect cell Expression Vector System
- HPV: Human Papillomavirus
- FDA: Food and Drug Administration

**RELEVANT REF.**

**CONCLUSIONS AND FUTURE PERSPECTIVES**

- BEVS is the most suitable and advantageous technology to produce VLP vaccines at large-scale
- The approval of Cervarix® meant the acceptance of BEVS technology and a boost to more VLP vaccines based on BEVS to reach the market
- Systems biology and genetic engineering are expected to improve both vector technology and bioprocess engineering