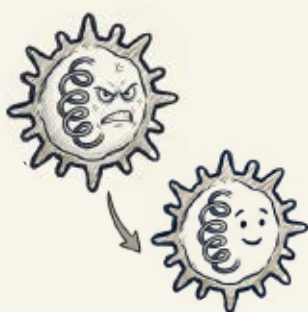


# FROM SEED TO SHOT (1): CLASSICAL VACCINE PRODUCTION IN 5 STEPS



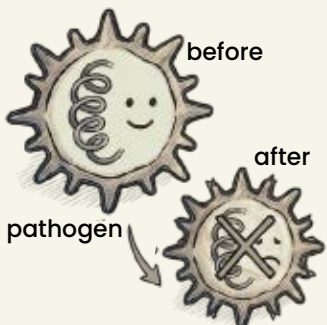
## What are we producing?

### Live attenuated



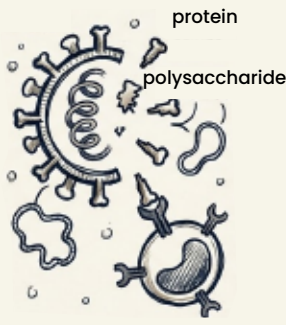
Weakened pathogen that still replicates but does not cause disease.

### Killed (inactivated)



Whole microbe grown, then chemically, physically or genetically inactivated.

### Subunit



Purified antigen (protein, polysaccharide, or conjugate), often produced recombinantly.

## The 5 core steps

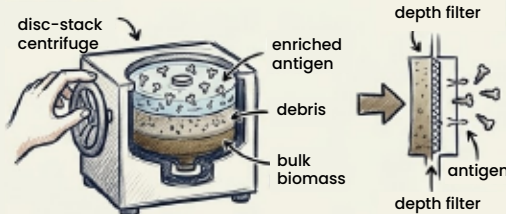
### 1. Expression:

- Amplify antigen in culture, cells or microbes starting from a well characterized seed stock [**Bacteria in stainless steel fermenters, viruses in cell culture bioreactors or embryonated eggs**].



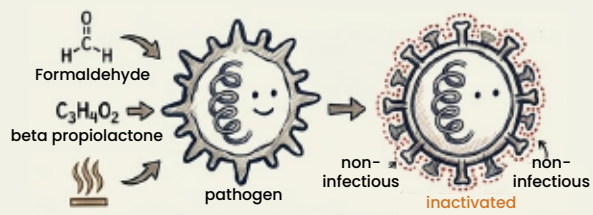
### 2. Harvest:

- Separate bulk biomass and debris to enrich the antigen.
- Examples:** Disc stack centrifuge, depth filters; optional detergent/solvent to extract intracellular antigens.



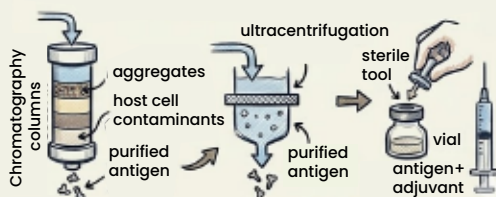
### 3. Inactivation (inactivated vaccines):

- Render pathogens unable to replicate or cause disease while preserving antigenic structure.
- Examples:** Formaldehyde, beta propiolactone, peroxide, heat; tightly controlled conditions.

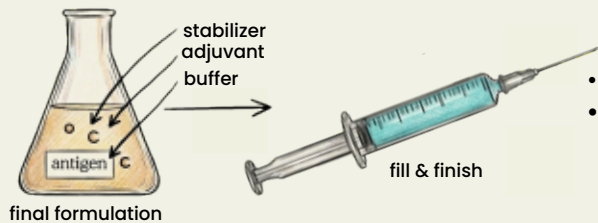


### 4. Purification:

- Remove process impurities, host cell contaminants and aggregates.
- Examples:** Chromatography columns, ultrafiltration, ultracentrifugation; orthogonal steps exploiting size, charge, hydrophobicity; sterile filtration where applicable.



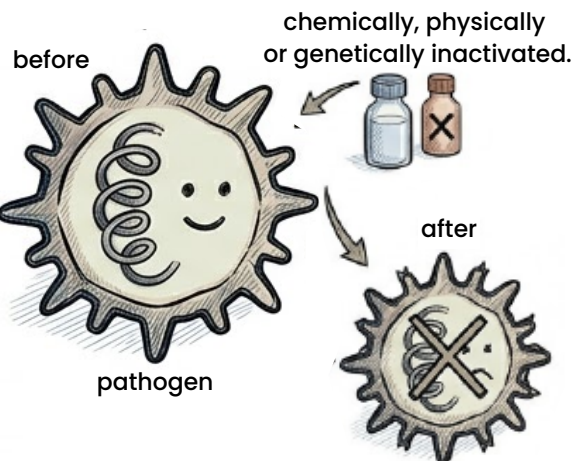
### 5. Formulation:



- Stabilize the antigen and prepare the final dose.
- Examples:** Buffers, excipients, adjuvants; lyophilisation for long term stability; filling into vials or prefilled syringes.

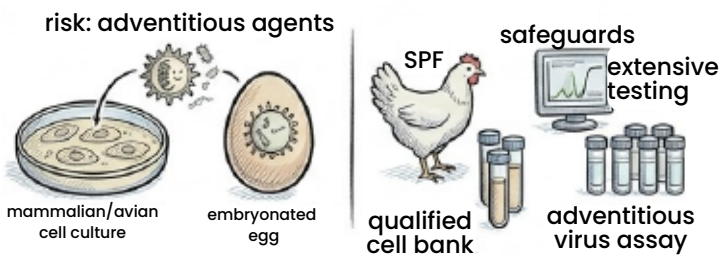
## "Pain points" and safeguards

### Inactivation control



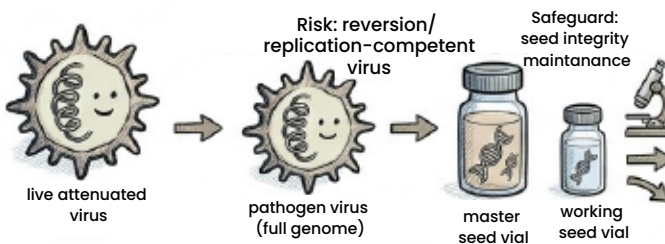
- Inactivated ("killed") vaccines:** conditions must inactivate pathogens without destroying key epitopes.

### Contamination control



- Eggs and cell cultures:** risk of adventitious agents → specific pathogen free flocks (SPF), qualified cell banks, extensive testing.

### Genetic stability



- Live attenuated and vectors:** monitor for reversion, replication competent virus, and maintain seed integrity.

## References

Adapted from: Porter F. Vaccine Production. In: Schmitt HJ, ed. Essentials in Vaccinology. Global Health Press; 2021. Chapter 12. . <https://vaccitutor.com/course/view.php?id=78>