The power of live Salmonella vaccines

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MENAGSE

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Salmonella Infection

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2 types of Salmonellosis

Salmonella is an **intra-cellular pathogen** that causes a very common intestinal infection in humans and domestic animals, called Salmonellosis.

Carvajal BG Vaccine 2008 The humoral and cell mediated immune response REF-05025

a. Paratyphoid (Public Health)

Barrow PA Salmonella in Domestic Animals 2000 323 REF-01760

- Ubiquitous / Many hosts
- Motile
- Vertical & Horizontal transmission (fecal-oral route)
- Poultry as asymptomatic carrier

Salmonella is one of the two most important food-borne pathogens globally.

There are more than 2600 serovars

Achtman M et al PLoS Path 2012 603 REF-02346

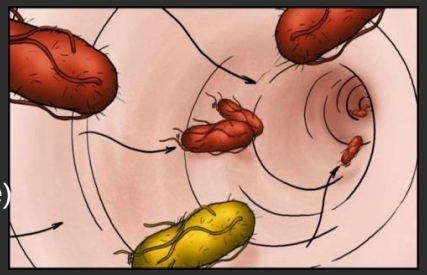
Salmonella serotype Typhimurium and *Salmonella* serotype Enteritidis are the most prevalent worldwide

Barrow PA Avian Pathology 2012 413 REF-02443

a. Typhoid (Poultry Health)

Barrow PA Avian Pathology 2012 413 REF-02443

- Host-specific avian *Salmonelle*
- Non-motile (without flagels)
- Vertical transmission (transovaric route)
- Birds suffer clinical disease



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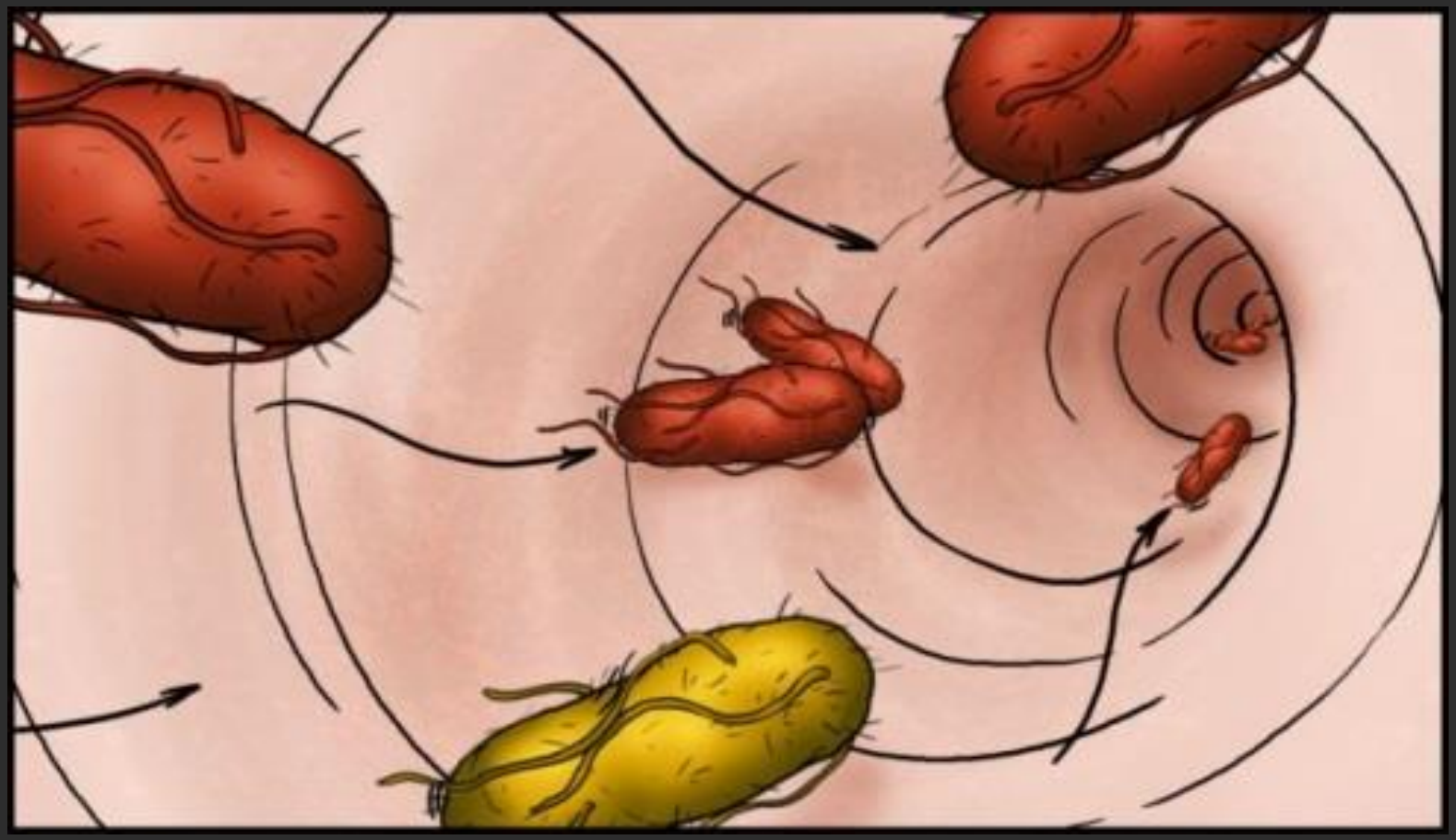
the *Salmonella* bacteria travels …



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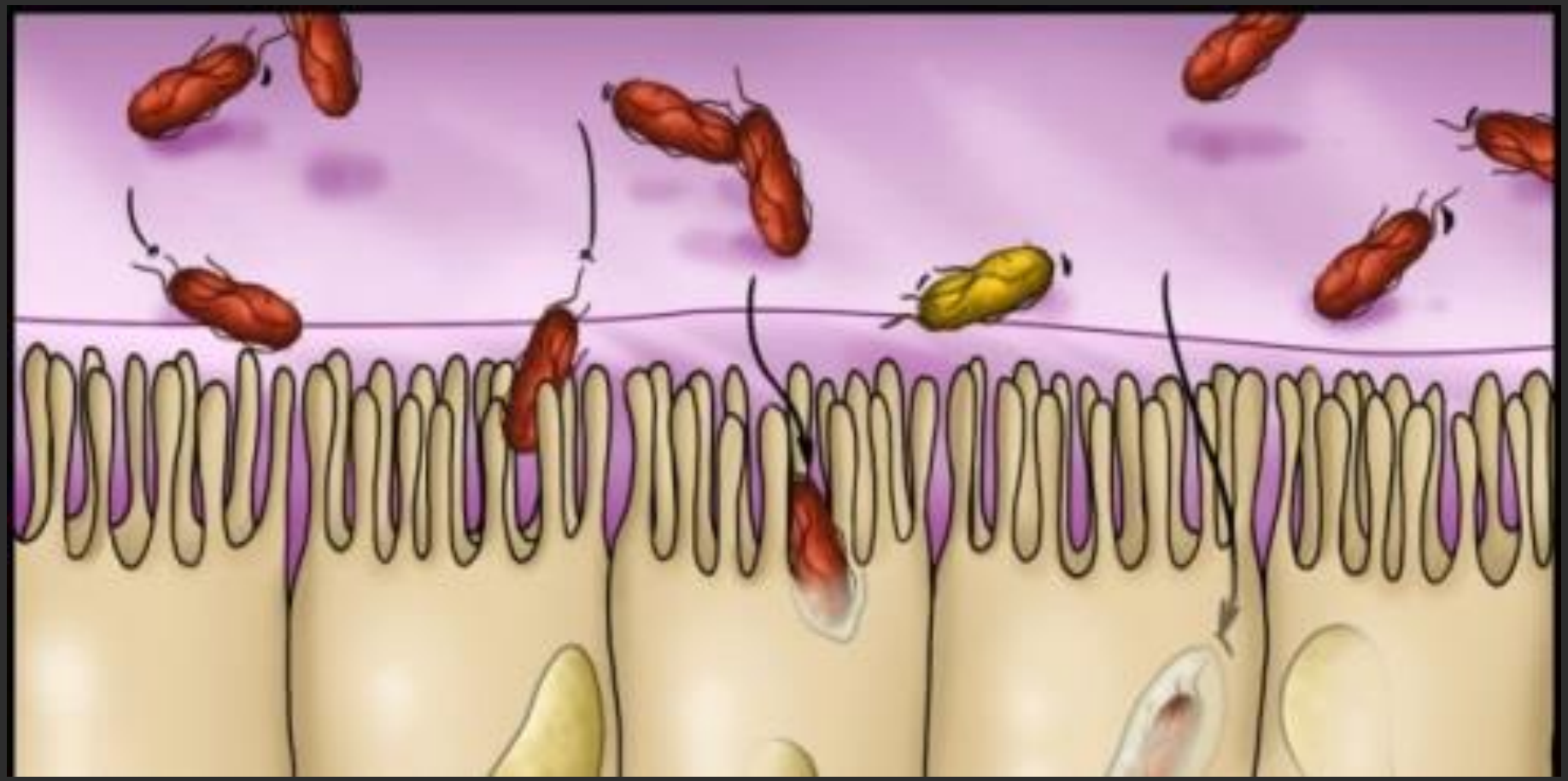
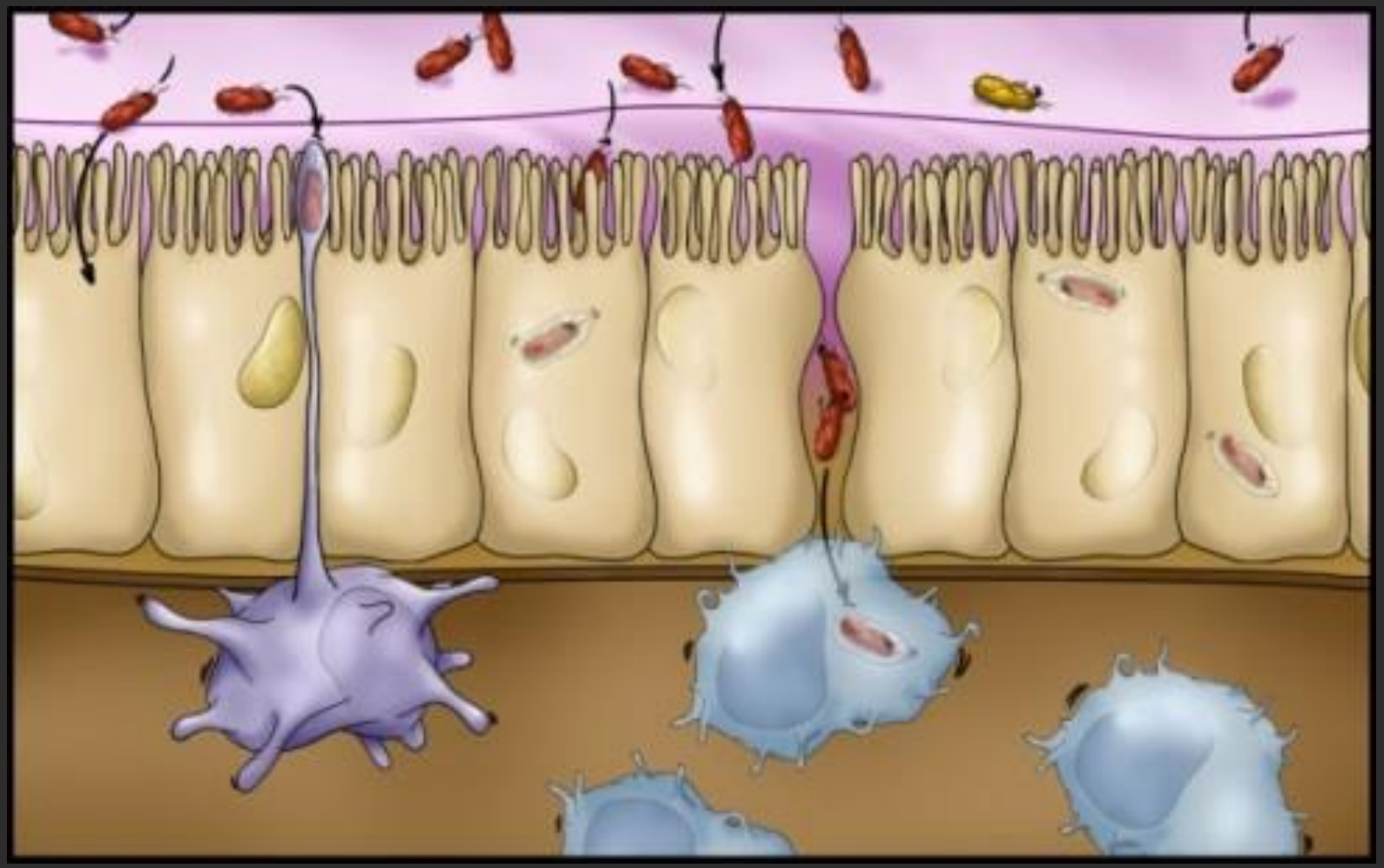


- … to the intestinal tract, where they penetrate the epithelial wall.



The innate immune system responds by triggering local macrophages and dendritic cells, which engulf the bacteria.

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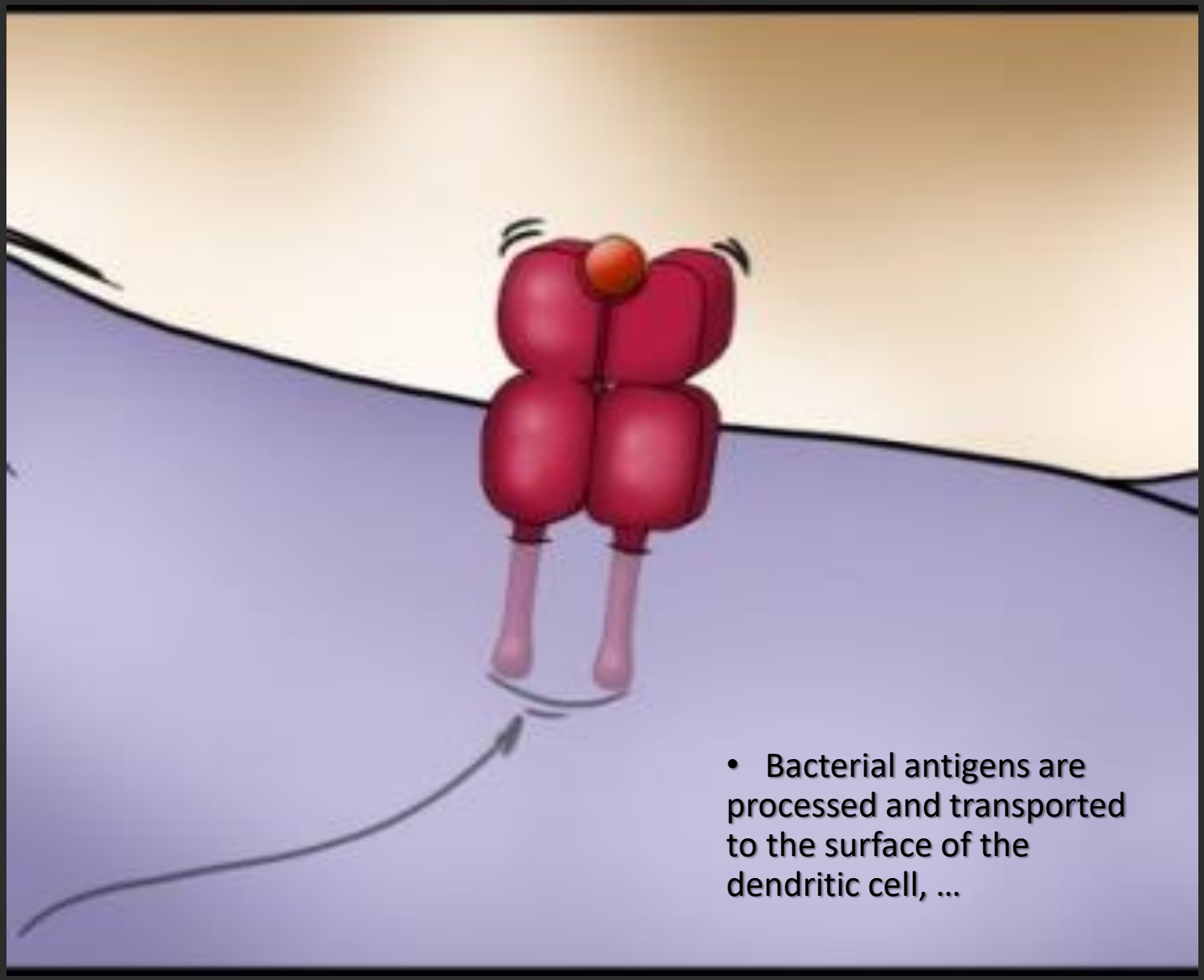
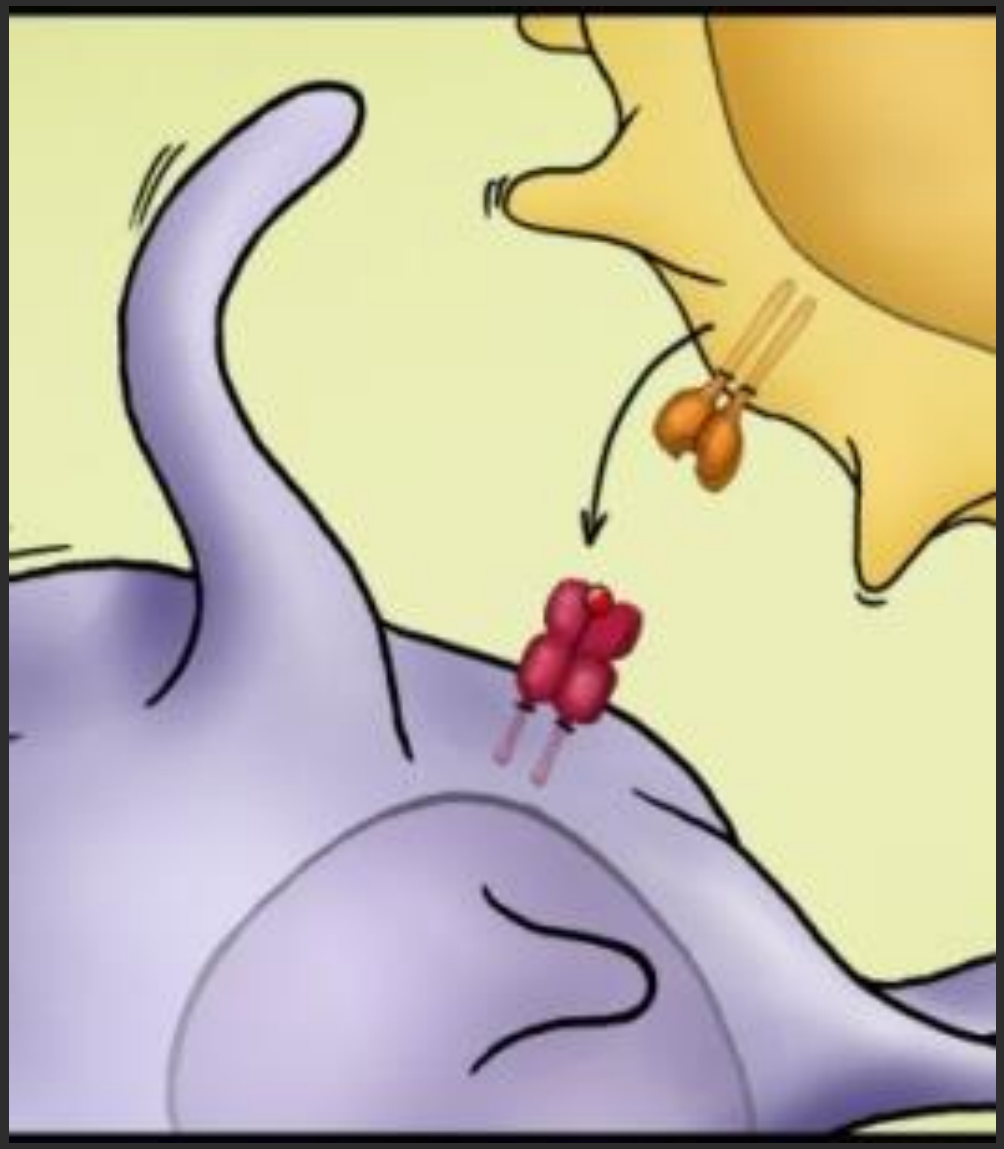
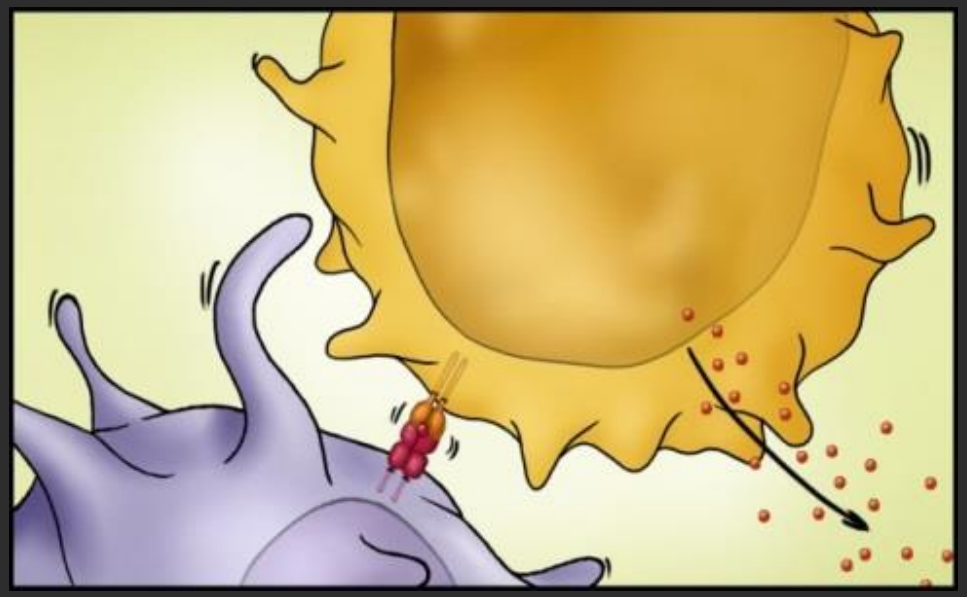


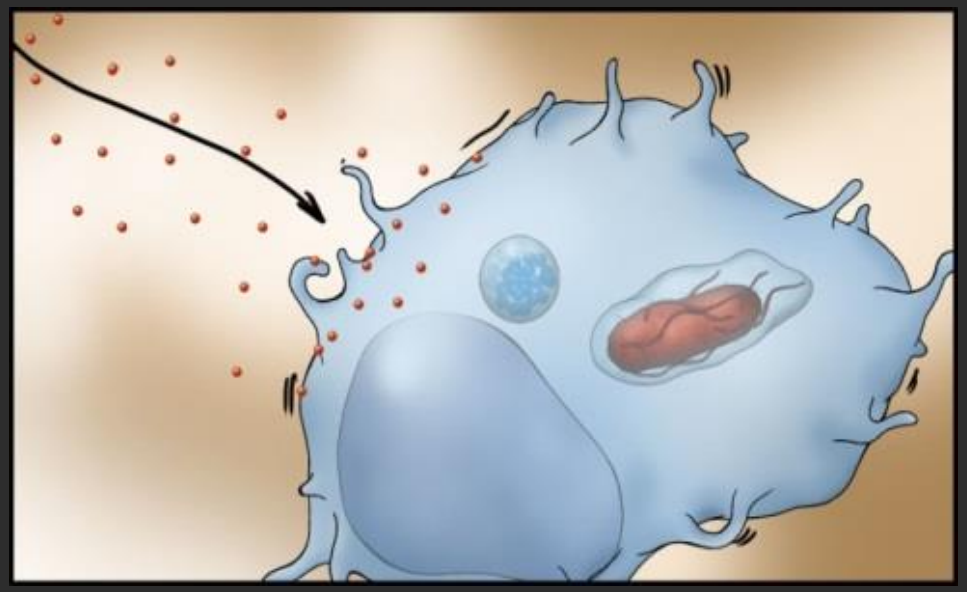


- … allowing T helper cells to recognize the foreign antigen.

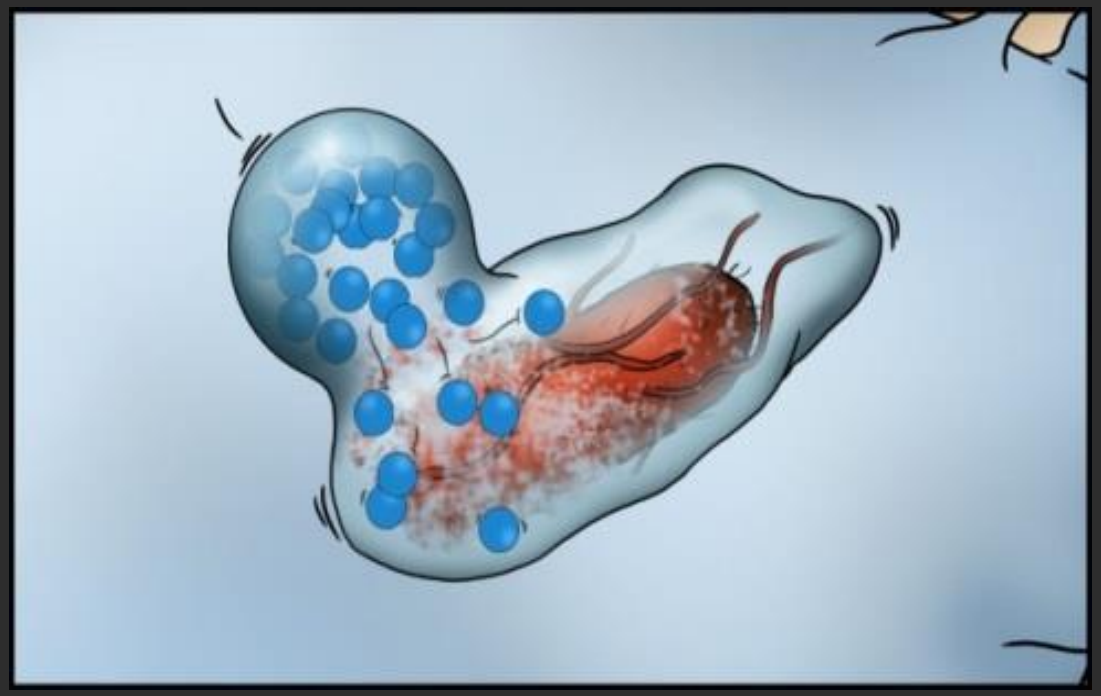
- This interaction prompts the T helper cell to release various messenger signals, which in turn …

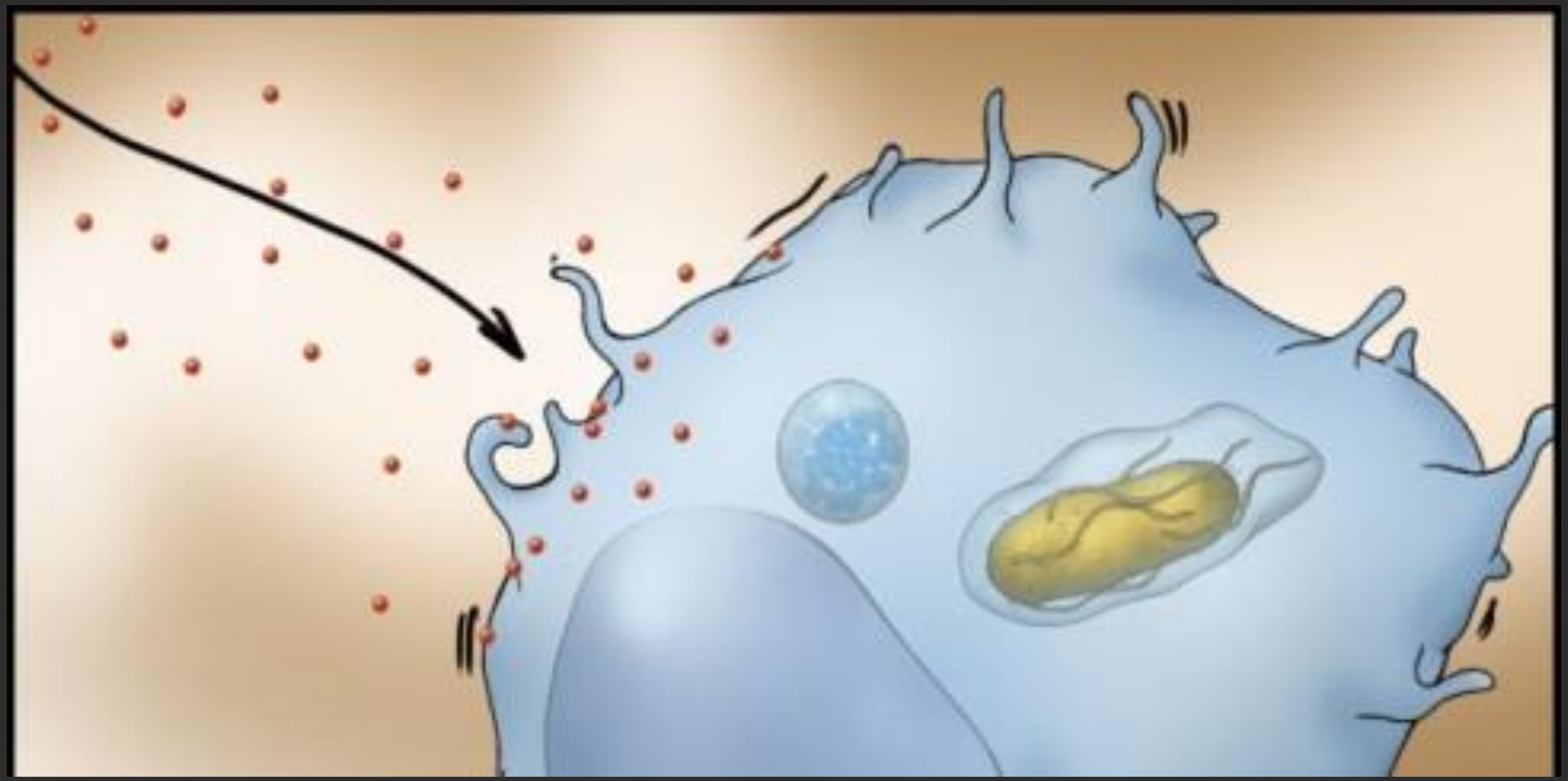


- … command the macrophages …

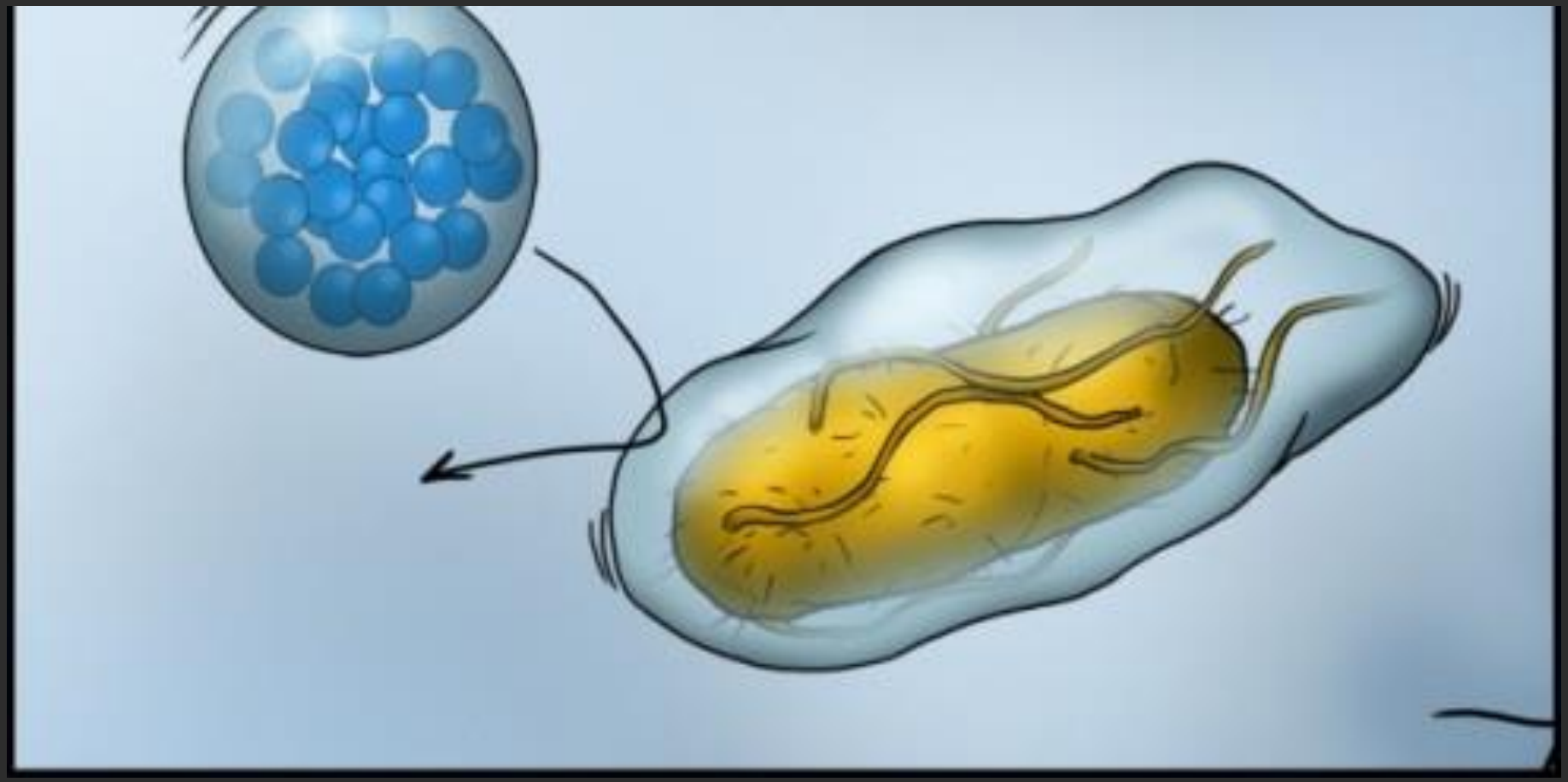


- … to eliminate the previously internalized bacteria. This elimination process is an integral part of the immune response and is generally effective in eradicating salmonellae.

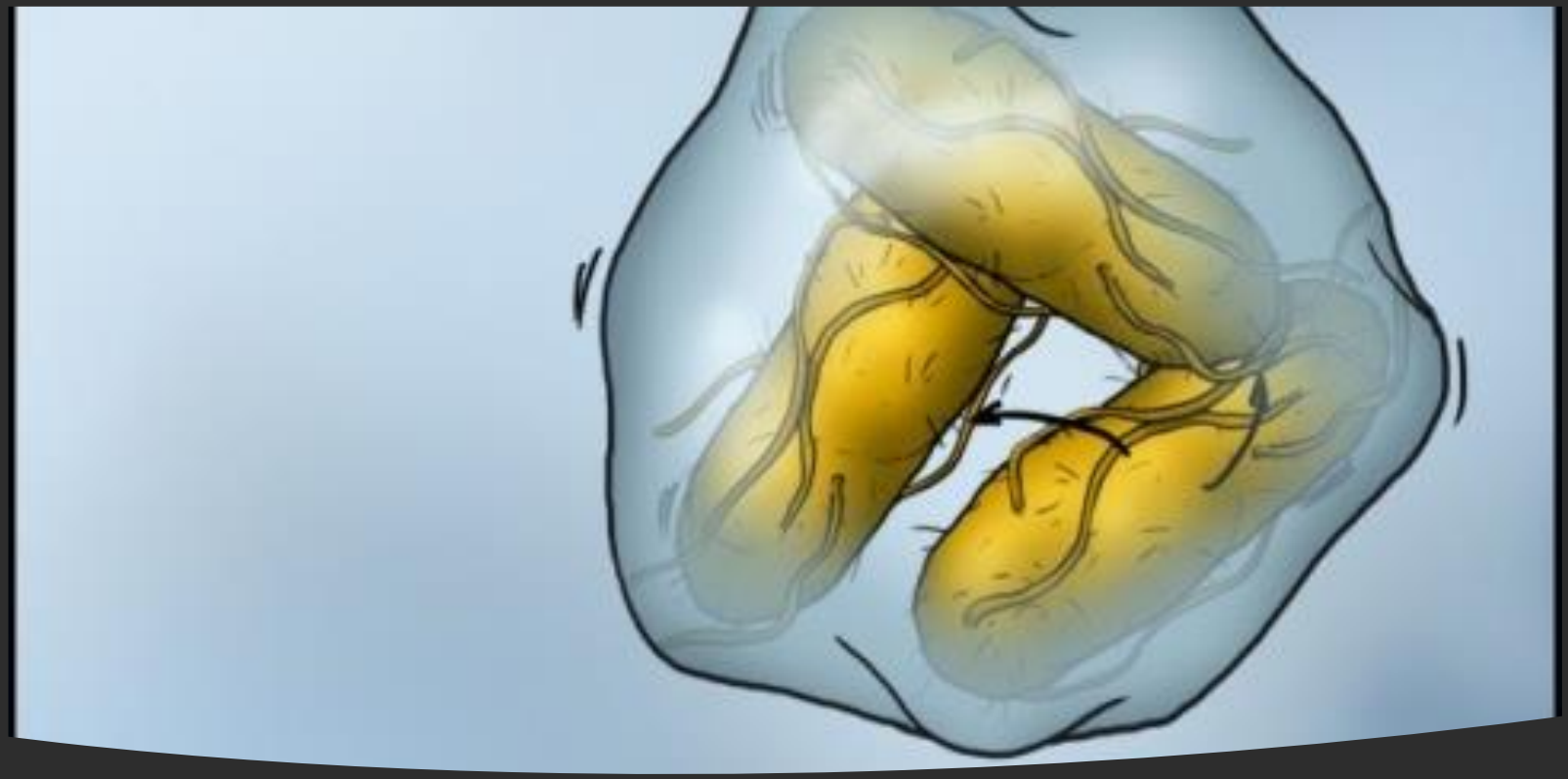




- However, some *salmonella* serotypes – including *Salmonella* Enteritidis and *Salmonella* Typhimurium …

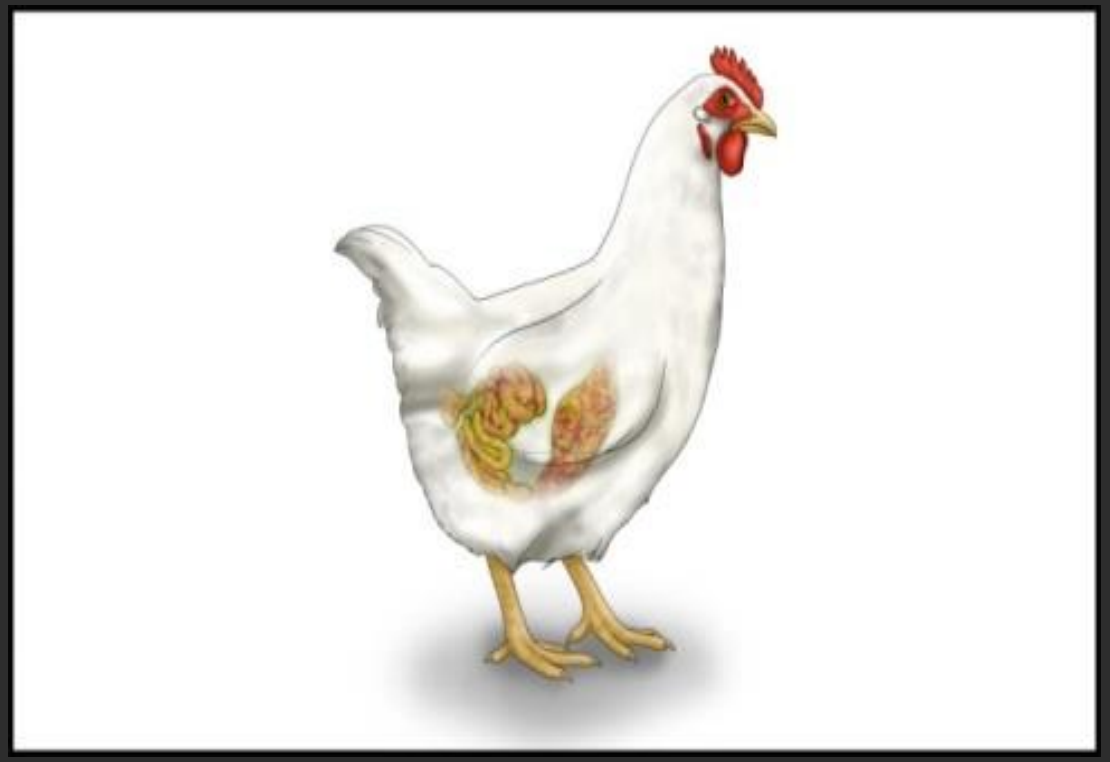


- … have developed ways to evade elimination.



- They continue to thrive and multiply within the macrophages …

- … and can be transported to other organs, spreading the infection systemically. Chickens can become life-long carriers of salmonellae, leading to contaminated meat and eggs.



Multiple Transmission Routes

Why the holistic approach against Salmonella ?

Sources of Infection

Gast RK et al Poultry Science 2016 1363 REF-06559

1. **RESERVOIRS:** poultry (Non-vaccinated & Replacement birds), cattle, swine, pets, wildlife
2. **RODENTS:** Rats (*Rattus norvegicus*), Mice (*Mus musculus*)
3. **PESTS:** Flies (*Musca domestica*), beetles (*Alphitobius diaperinus*), Red mites (*Dermanyssus gallinae*)
4. **SURFACES:** Transport , Equipment, Housing
5. **OTHERS:** people, Water, Feed bedding & Litter

Risk factors

Denagamage TN Dissertation 2016 REF-02217

1. Induced molting
2. Larger flock size (>30,000 hens)
3. Multiage management, without "*all-in, all-out*"
4. Cage housing systems
5. In-line egg processing
6. Rearing pullets on the floor
7. Middle and late phase of production
8. Egg production rate of >96%
9. Presence of previous Salmonella infection
10. Absence of cleaning and disinfection
11. Presence of rodents
12. Pests with access to feed
13. Visitors allowed in the layer houses
14. Trucks near farms and air inlets
15. Manure contamination
16. Egg-handling equipment contamination

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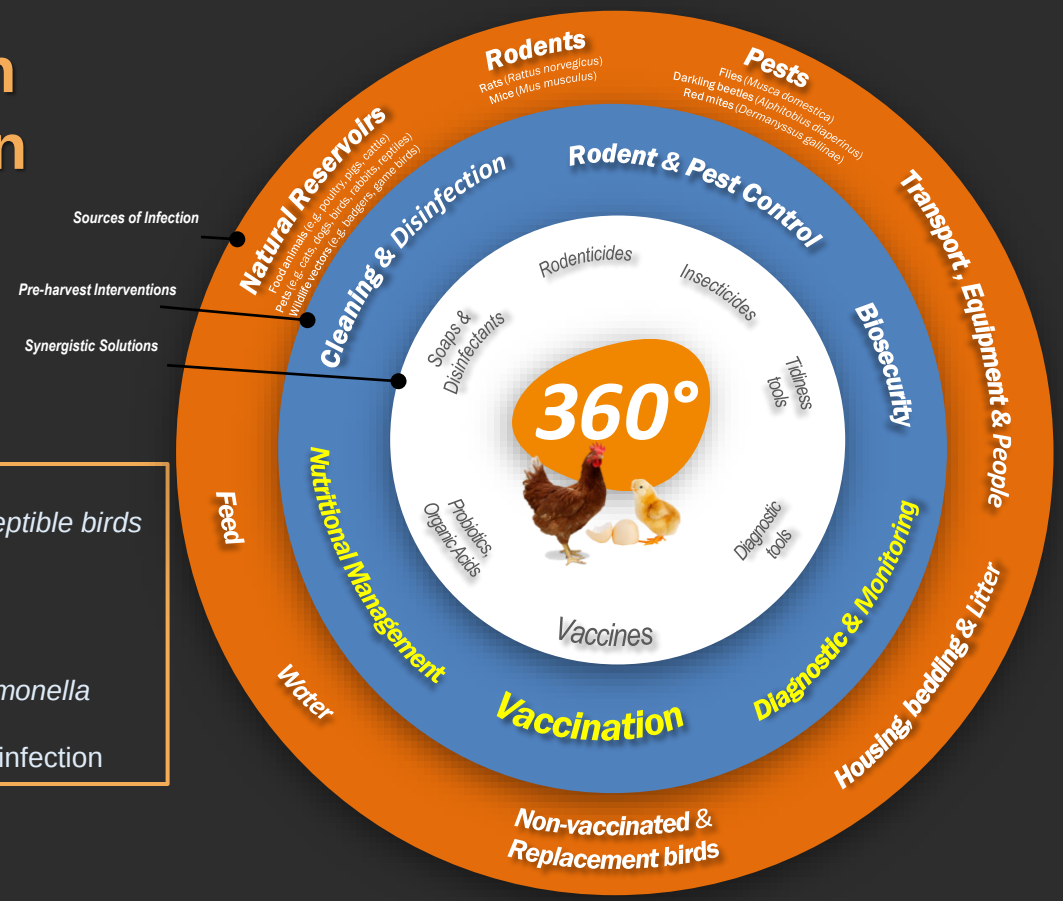
Vaccination:
The Essential Foundation for *Salmonella* Prevention



Specific Interventions

- ***Objectives***: *Build bird immunity and prevent spread to susceptible birds*
- ***Examples***: Vaccination, diagnostic & monitoring, nutritional management

General Interventions

- ***Objectives***: *Reduce the infection pressure and prevent Salmonella from entering the farm*
- **Examples**: Biosecurity, rodent & pest control, cleaning & disinfection

Gast RK et al Poultry Science 2016 1363 REF-06559

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Controlling *Salmonella*: 2 types of Vaccines

	LIVE	INACTIVATED
AGE OF FIRST VACCINATION	Can be safely used from Day 1 of age (No gap in protection)	Often used from 8th week of life with re-vaccination 4 weeks later
APPLICATION METHOD	Drinking water or coarse spray	Subcutaneous or intramuscular injection
ONSET OF IMMUNITY	Reliable immunity built within a few hours post vaccination	Immunity built after a 2nd vaccination
MODE OF ACTION	1. Colonisation Inhibition (CI) effect 2. Local immunity (secretory IgA) 3. Cellular mediated immunity *Salmonella* field strains neutralized before entering the intestinal wall	1. Humoral immunity, production of high levels of IgG and IgM *Salmonella* field strains can only be neutralized after entering the intestinal wall and reaching the bloodstream
CROSS PROTECTION	Published data demonstrates cross protection	Little data available to demonstrate cross protection
INTERFERENCE WITH MONITORING	Minimal interference with serological monitoring (Reliable differentiation using bacteriological method)	Levels of interference with serological monitoring

SPC Elanco Avirpro Salmonella 2016 REF-02844

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- Carvajal BG Vaccine 2008 5423 The humoral and cell mediated immune response REF-05025
- Shahin A University Library Electronic Theses 2005 1 REF-06418
- Shivaprasad HL et al Diseases of Poultry 2013 678 REF-03374
- Singh BR The Open Vaccine

Revolledo L Journal of Applied Poultry Research 2012 418 REF-04249

Barrow PA Salmonella in Domestic Animals 2000 323 REF-01760

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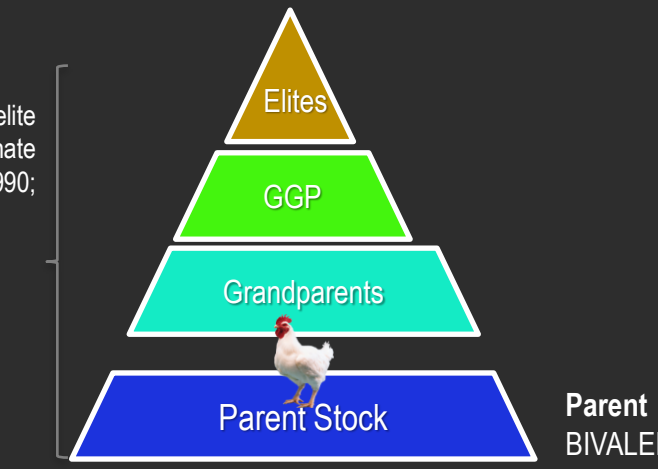
Top-down Industry Approach

How vaccines deliver immunity ?

- McReynolds JL et al J Appl Poult Res 2007 456 (v1.0) REF-00139 — Evaluation of a Competitive Exclusion Culture and Megan Vac 1 on Salmonella Typhimurium Colonization in Neonatal Broiler Chickens

If you are a managing elite flocks, you must eliminate salmonella (Cox, 1990; Lahellec, 1985).



Parent stocks are usually immunized with BIVALENT <u>live and/or inactivated</u> vaccines

BIVALENT-LIVE KILLED

Layer immunization with SE-ST live vaccines:

- Triggers immunity based on 3 immune mechanisms:
  - Colonization Inhibition effect
  - Secretory IgA
  - Cell-mediated immunity
- Enables cross protection against serovars of group D (S. Gallinarum)

Broiler immunization with ST-live vaccines:

- Can be applied in the hatchery, or in the farm during first days of age, which is the most critical stage of a chick's life
- Can confer protection through non-specific Competitive Exclusion (<u>McReynolds et al 2007</u>)
- Can complement the breeder program → contributing to integrated outcomes in the processing plant

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Thank you

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