

Establishing Gamma Irradiation Parameters for Pathogen Inactivation in Vaccine Production and their Application to Serum Inactivation

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Seibersdorf research and development laboratories



5 laboratories are under Joint FAO/IAEA
Centre of Nuclear Techniques in Food and
Agriculture

APHL ACTIVITIES

Research and Innovation (nuclear, nuclear-related, and molecular techniques)

- Molecular and serological assays, Sequencing and next-generation sequencing and Molecular epidemiological studies
- Development of vaccines and immune assays
- AMR in animal production environment
- Livestock biodiversity characterization, sustainable genetic improvement and marker assisted breeding
- Assisted reproductive biotechnologies



APHL ACTIVITIES

- Capacity building and technology transfer
 - VETLAB Network, Zodiac and Atoms4Food
 - TCPs, CRPs
 - On-site training, Fellowship training, Group trainings
- Networking, data sharing and services
 - The VETLAB Network
 - Service (ring trials, shipment, calibration)
 - WOAHA Collaborating Centre for ELISA and molecular technologies in Animal Disease Diagnosis

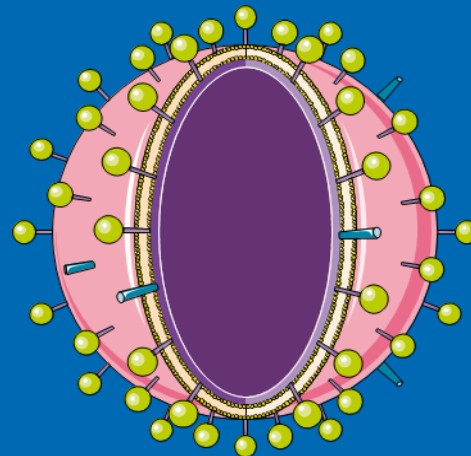
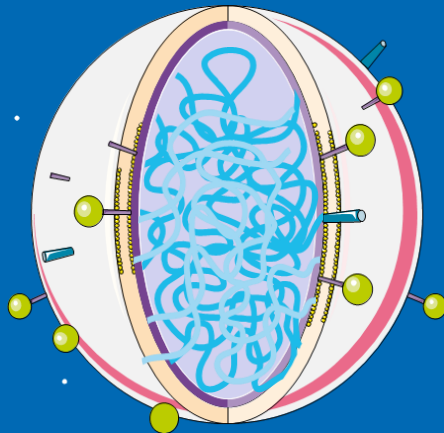
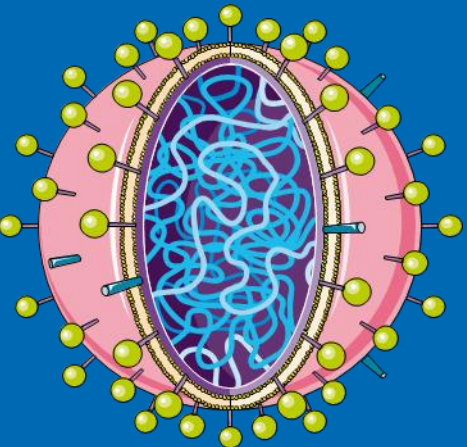
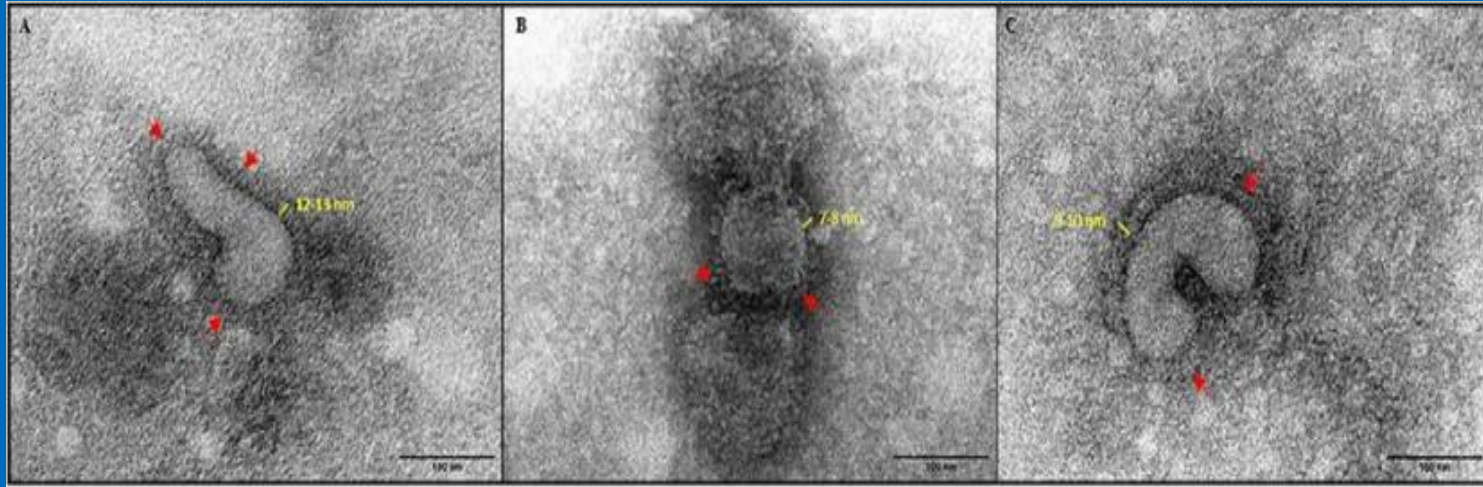


Irradiation inactivation of a pathogen

Live

Chemically
inactivated

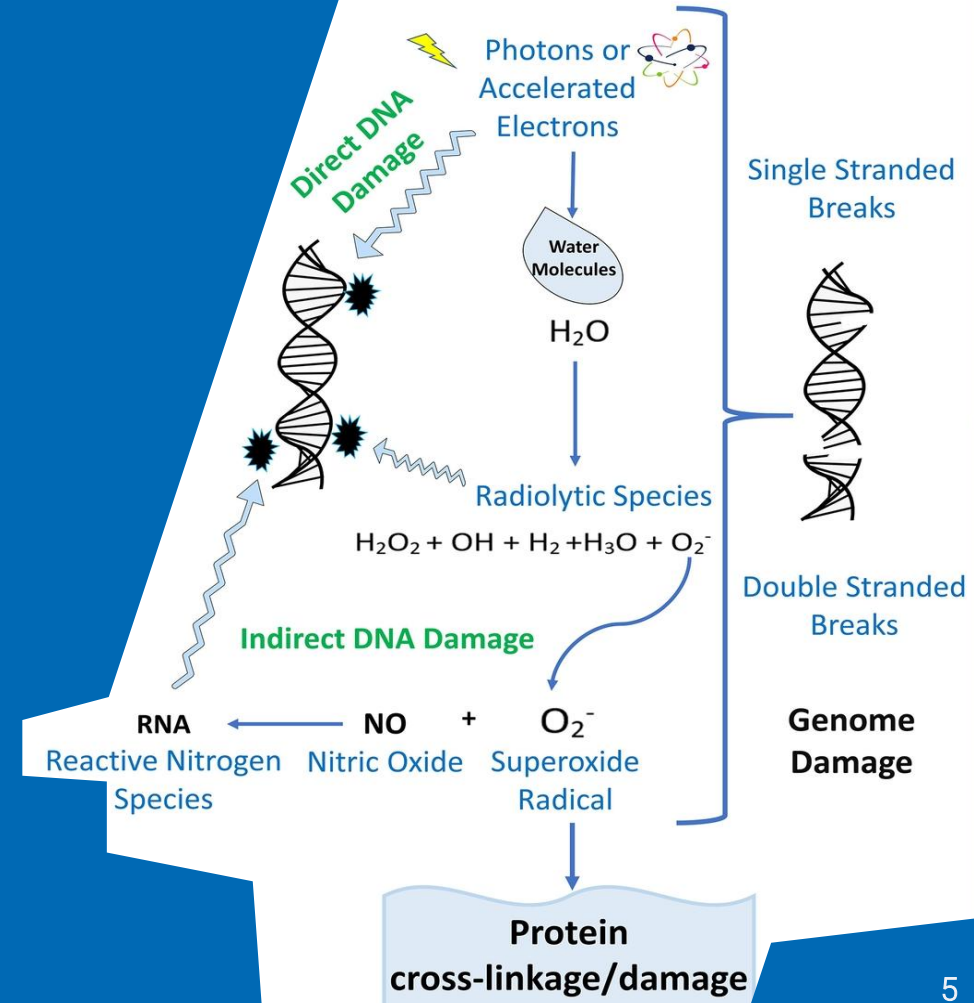
Irradiation
inactivated



3. Irradiation Primarily Damages Nucleic Acid

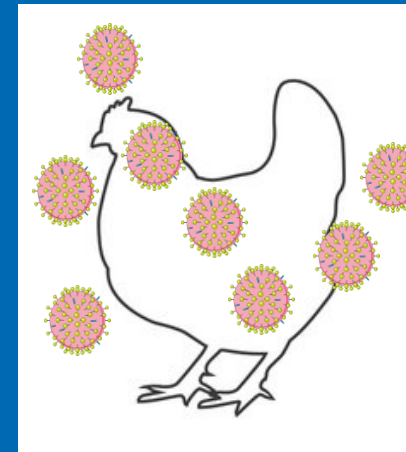
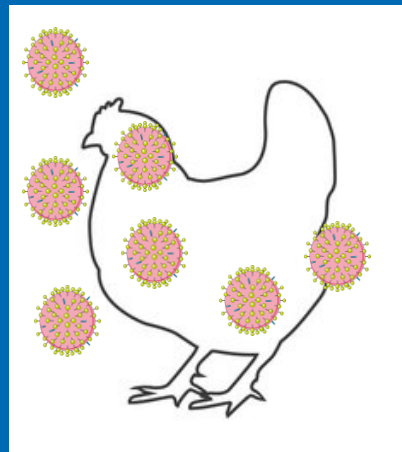
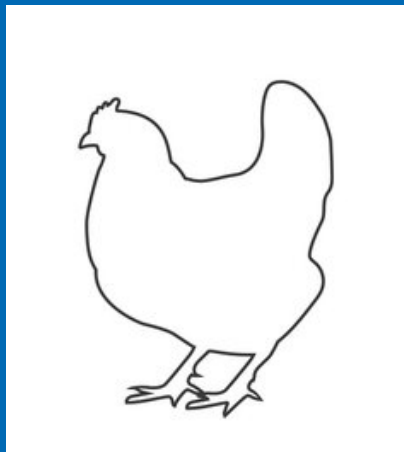
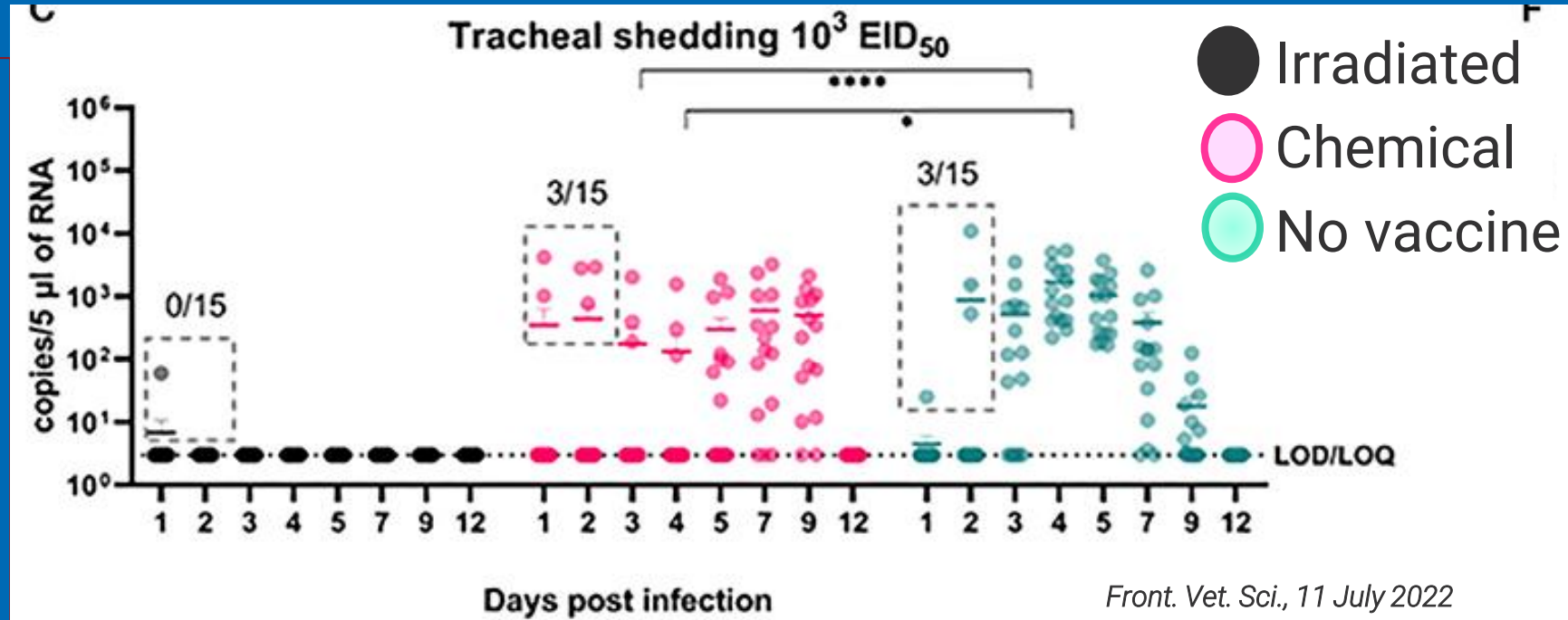
Direct
Damage

Indirect
Damage



Irradiated vaccine: inactivated virus vaccines

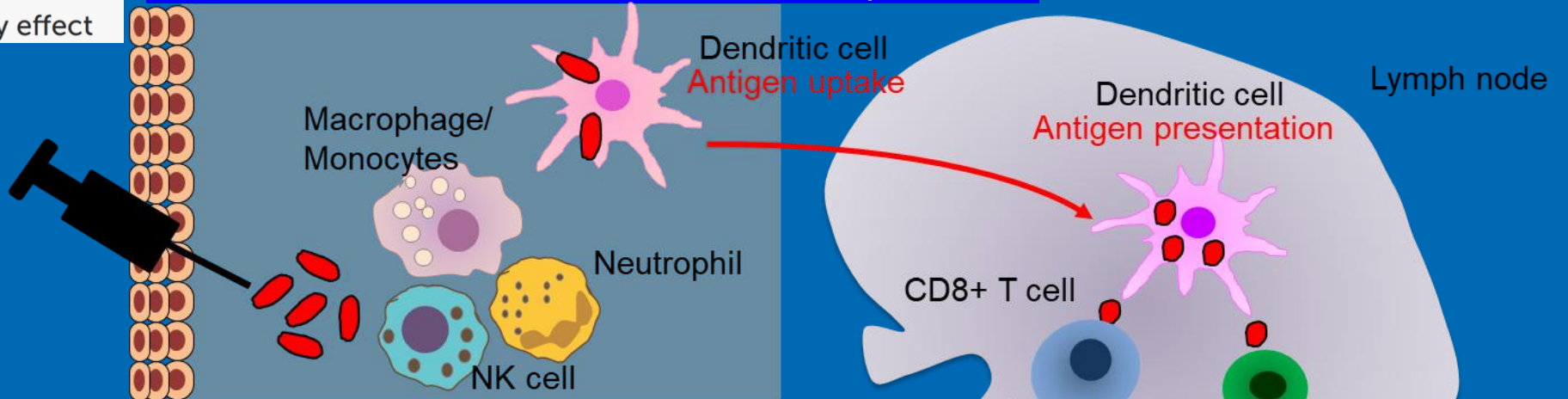
Avian influenza vaccinated through oronasal route and challenged



Innovation

Aerosol vaccination of chicken pullets with irradiated avian pathogenic *Escherichia coli* induces a local immunostimulatory effect

Innate & Mucosal immune responses



> Immunity. 2006 Jul;25(1):143-52. doi: 10.1016/j.immuni.2006.05.013.

Vaccination with irradiated *Listeria* induces protective T cell immunity

Cell-mediated



Broad humoral

Intranasal vaccination with γ -irradiated *Streptococcus pneumoniae* whole-cell vaccine provides serotype-independent protection mediated by B-cells and innate IL-17 responses

Adaptive immune responses

Compliance, Promise and Sustainability



Sanaria PfSPZ
Malaria vaccine
Phase I/II trials



GPN Gamma-PN
pneumococcal
Vaccine Phase I/II
trials



MSD Huskvac
Bovine lungworm
Vaccine 40 years
in the market

Initiatives by the IAEA

Over 40 animal and zoonotic pathogens targeted last two decades

PRODUCTION AND UTILIZATION
OF RADIATION VACCINES
AGAINST HELMINTHIC DISEASES

REPORT OF A PANEL ON
THE PRODUCTION AND UTILIZATION OF RADIATION
VACCINES AGAINST HELMINTHIC DISEASES
HELD IN VIENNA
16-18 DECEMBER 1963



Discovery research

- Inactivation dose
- Preservation of antigens
- Publications and protocols

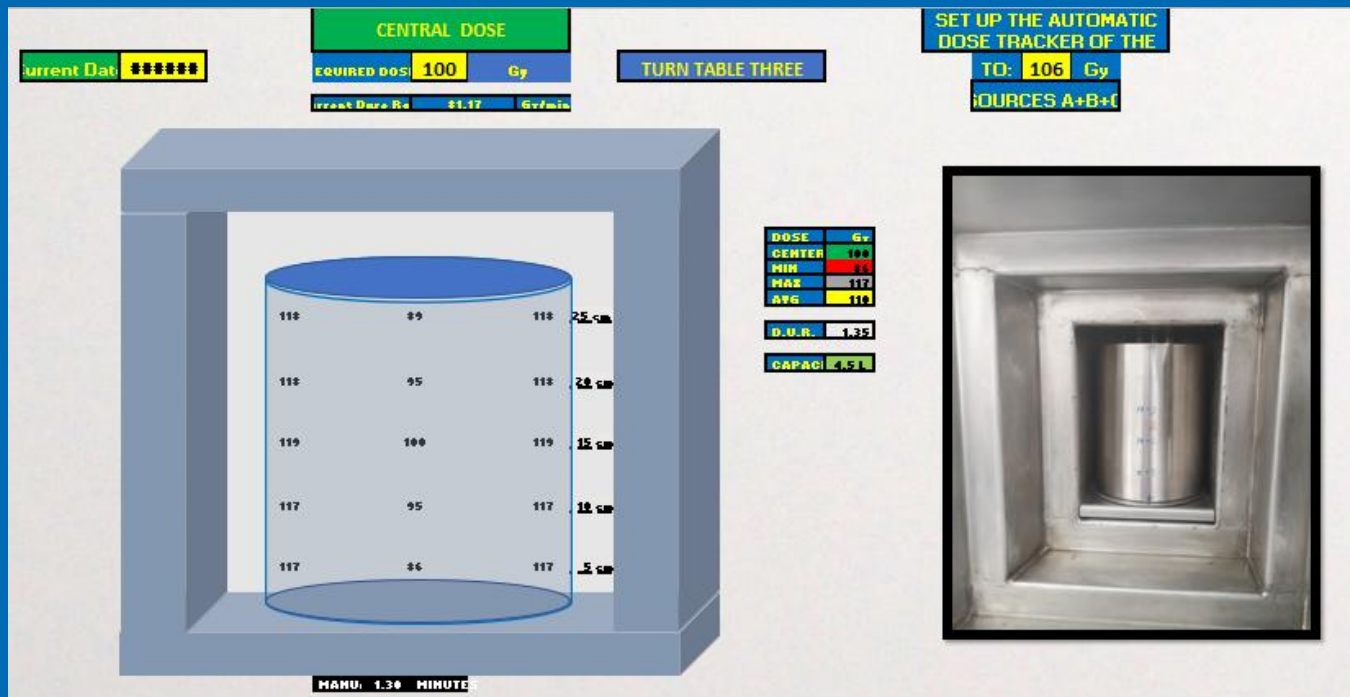
Process development

- Inactivation conditions
- Vaccine formulations
- Stability and shelf life

Proof of concept

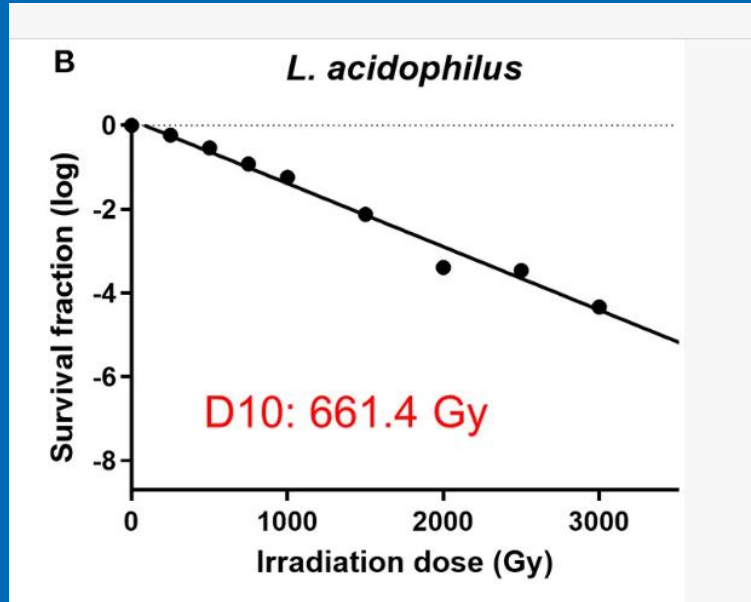
- In –vitro efficacy
- Animal experiments
- Field experiments
- Patents
- License

Calculating D_{10} and SAL Values at APHL

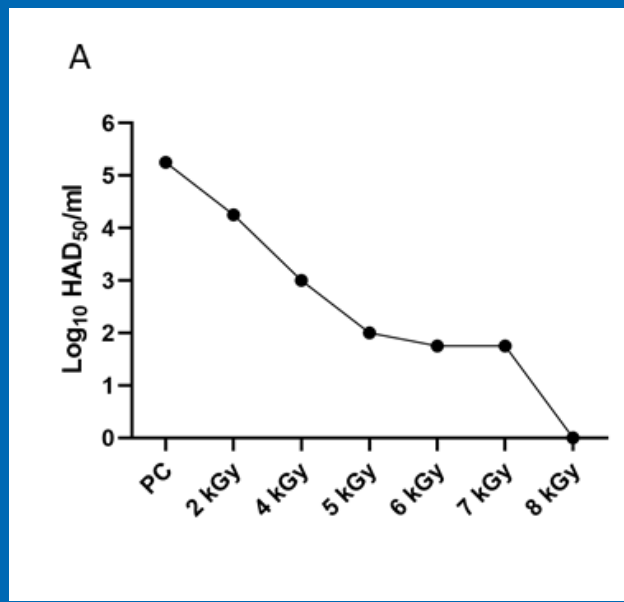


- D_{10} is dose in Gy needed to reduce active pathogen by 1 Log
- SAL is the Sterile Assurance Level
- D_{10} & SAL quick to calculate if pathogen has a linear relationship with irradiation (Linear regression)
- Some organisms have a non-linear relationship where D_{10} is calculated using a mixed regression model

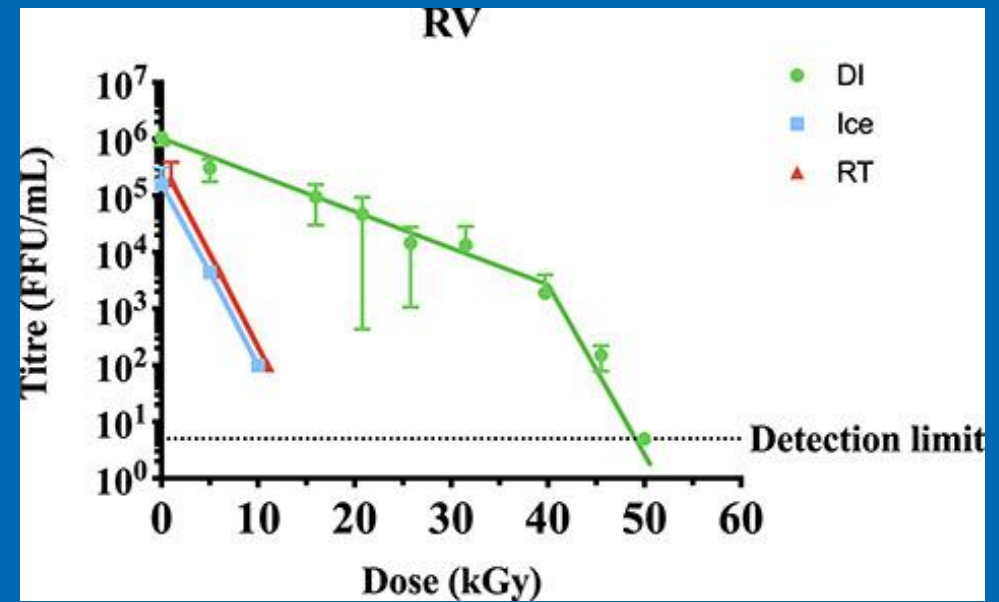




Front. Vet. Sci., 18 May 2022
 Sec. Veterinary Infectious Diseases
 Volume 9 - 2022 | <https://doi.org/10.3389/fvets.2022.859124>

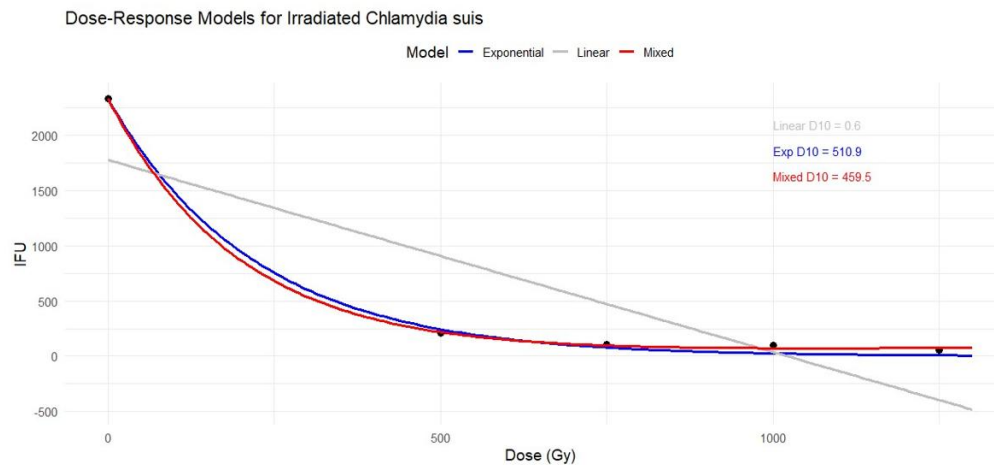


Front. Immunol., 26 April 2022
 Sec. Vaccines and Molecular Therapeutics
 Volume 13 - 2022 | <https://doi.org/10.3389/fimmu.2022.832264>



J Radiat Res. 2020 Sep 15;61(6):886–894. doi: [10.1093/jrr/rraa076](https://doi.org/10.1093/jrr/rraa076)

Chlamydia suis



The Exponential model provided the best fit to the data, and its curve closely matched the observed rapid decline in inclusion-forming units (IFU) at lower doses followed by a gradual decrease at higher doses. The Mixed-effects model performed similarly but added complexity without significant improvement. In contrast, the Linear model was unsuitable because the relationship between dose and IFU was clearly nonlinear. The Exponential model was selected as the most appropriate for estimating D10 for *Chlamydia suis* under irradiation. 1.2×10^9 frozen *C. suis* samples were irradiated at a dose of 5660 Gy (Inactivation plus 2D10 for SAL dose). The linear model would be calculated at 27Gy

What's next



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