Biosafety for containment and handling of arthropods: Training program using a virtual reality (VR) tool

Dr Eva Veronesi (RVC, UCL)
University of Zürich (Institute of Parasitology)
Zürich
Switzerland

University of Zurich[UZH]

EVA VERONESI

Medical and Veterinary Entomologist

2017 - Ongoing **Consultant**
Capacity building for emerging diseases, training on field and laboratory techniques for arthropod surveillance, control, identification and infection with vector-borne pathogens

Networking Stakeholder Coordinator for Horizon2020 Infravec2 project (EC)
- Strengthening capacity building and technical cooperation for prevention of emerging animal and zoonotic infectious diseases
- Trainer on CL3 biosafety laboratories
- Science communication

2014 - 2020 **Senior Scientist Medical & Veterinary Entomology**
National Centre for Vector Entomology (Institute of Parasitology, UZH, CH)
- Interaction between virus pathogens (Zika, dengue, west-Nile, bluetongue, Lumpy skin disease) and arthropods vectors (mosquitoes and *Culicoides* biting midges)
- Field training of arthropods surveillance and control methods

2002 – 2014 **Research Scientist in Med&Vet Entomology** (The Pirbright Institute, UK)
- Assessing parameters involved bluetongue virus transmission
- Evaluating safety and efficacy for live attenuated vaccines against bluetongue virus

1995 – 2002 **Research Scientist in Med&Vet Entomology** (Centro Agricoltura Ambiente, Italy)
- Surveillance, control, rearing and biological investigation of vector mosquitoes, sand flies, simulidae and *Culicoides*

Training and teaching activities

Training courses

- Infection of live arthropods under biosafety conditions
- Using Standard Operating Procedures (SOPs) for field and laboratory investigations
- Field collection, surveillance, and control of arthropods vectors
- Identification of arthropod vectors (mosquitoes and *Culicoides* biting midges)

Teaching

- Biology and control of arthropod vectors
- Experimental design for laboratory assessment of insect-virus transmission
- Biological and molecular techniques for virus detection, virus quantification, and arthropods infection

European Biosafety Association (EBSA), Swiss Federal Food Safety Veterinary Office (FSVO), Swiss Federal Office of Public Health (FOPH), Istituto Zooprofilattico Sperimentale delle Venezie (IZSV), International Atomic Energy Agency/Food and Agriculture Organization (IAEA/FAO).

Editing of "Guidelines for the design and operation of containment level 2 and 3 insectaries" for Infravec2 Horizon2020 EC grant www.infravec2.eu .

Biorisk management: what do we need to consider?

1. Environment protection
   (e.g. containment of exotic or GM arthropods)

2. Animal/human protection
   (e.g. containment of arthropods that could be infected)

3. Laboratory protection
   (e.g. contamination of laboratory species with "outsider" infected species)

Arthropod facilities

Rarely dedicated designs

- Separation between production/infection areas
- Total containment of colonies is challenging

Awareness

- Enviroment
- Infrastructures
- Laboratories
- Access control (logbook)
- Material (walls, concrete, floor)
- Colour
- Illumination
- Rearing cages
- Cages material
- Escape management

Awareness

- Enviroment
- Infrastructures
- Laboratories
- Access control (logbook)
- Materials (walls, concrete, floor)
- Colour
- Illumination
- Rearing cages
- Cages material
- Escape management

„WORKING MATERIAL" !

Arthropods categories and risks

1. Arthropods FREE of pathogens
2. Arthropods WITH pathogens
3. Arthropods WITH unknown infectious agents or uncertain status of infection
4. Genetically modified arthropods

1. Arthropods **FREE** of pathogens

- Is this species locally established?
- Exotic species?
- What about the agent?
- Transmission rate/vector competence?
- Origin of the species: phenotype variations
- Specific control or eradication methods?
- In case of their escape: viability of the strains

2. Arthropods **WITH** pathogens

- Check with sources for pathogen risk associated
- Define its pathogenicity, disease incidence and severity
- Route of infection (biting, airborne, ingestion)
- Protection: prophylaxis/vaccination (compulsory)
- Evaluation of at risk personnel skills
- Additional education training
- Containment level....and within the level!

3. Arthropods **WITH UNKNOWN** infectious agents or uncertain status of infection

Which containment level to adopt!??

Gain as much information as possible:

- Why is the infectious agent suspected?
- Route of transmission?
- Horizontal transmission?
- Novel agent? Introduction?
- Epidemological data available?
- Morbidity and mortality rate of the agents?

4. Arthropods **WITH UNKNOWN** infectious agents or uncertain status of infection (**field collected**)

Check the area where they come from (diseases-endemic)

Handle them as if they are positive for pathogen

5. Genetically **modified arthropods** (also including contained modified microbes)

- Establish the phenotypic change and impact of their possible escape:

  Vector competence, insecticide resistance, lifespan, viability for their escape, fertility rate, impact on wild population, code sequences defined (traceability), vertical/horizontal transmission.

Biosafety Level 3 (BSL-3)

- Differential negative pressure
- Double doors
- Air pressure alarm
- Exaust air system ventilation (HEPA filters)
- Clean area and „dirty" area

BSL-3 Infected arthropods

Safety guidelines (personnel consideration):

- Gloves
- Suit (no dark colours)
- Eye and face protection (helmet/mask, googles)
- Access restrictions/Training
- Logbook (entry/exit)
- Video (room requirements)
- Medical surveillance programme and check

BSL-3 Infected arthropods

Safety guidelines (facility considerations):

- Limited access to trained personnel
- Double-door vestibule (open one at time)
- Two-self closing doors
- Differential negative pressure (air pressure alarm)
- Sticky traps, insect-o-cutors; ovitraps, reduction of "hiding places/items"
- Filters, air curtains, drains
- Limited pipework, electrical ports
- Room size
- Floor, walls, colours, material, illumination
- Autoclaves/sterilization instruments
- Escape control measures

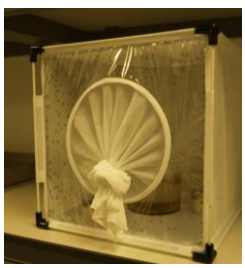
BSL-3 Infected arthropods

Safety guidelines (facility considerations):

- Room barriers could also be consisted of a zippers screened doorway
- All insects are counted (before and after working)
- Remaining arthropods MUST be discarded into a screw capped jar with 10% sodium hypochlorite
- Decontamination of glovebox after any work with virus-exposed insects!
- Emergency light can be switched off during non-working hours (UV light more attractive)

Rearing containments

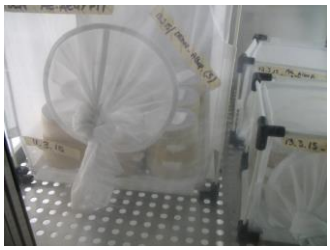
Primary containment: Screened mesh, robust cages



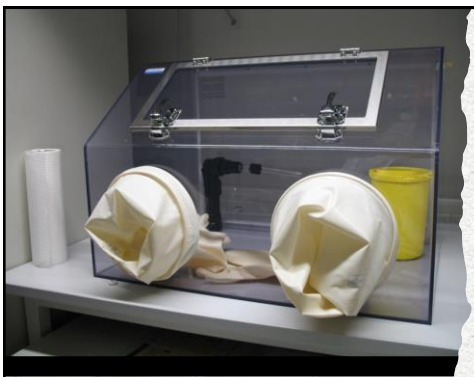
Secondary containment: See through sealed container

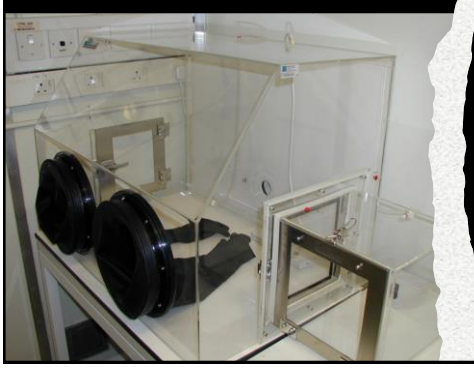
Incubators

CL-3 Infected arthropods



- See through incubator and cages
- Triple barriers of containment





- Reduce exposed skin area
- Glovebox
- Safety cabinet (HEPA filter)
- Safety manual (SOPs, waste management, emergency procedures)
- Testing/maintenance

Arthropod Containment Level	1		2	3	4
Arthropod distribution, escaped arthropod fate	exotic, inviable or transient	indigenous	exotic, indigenous, and transgenic		
Infection status	uninfected or infected with non-pathogen		up to CL-2	up to CL-3	CL-4
Active VBD Cycling	no	irrelevant			
Practices	CL-1 Standard Arthropod- Handling Practices		CL-1 plus more rigorous disposal, signage, and limited access	CL-2 with more highly restricted access, training and record-keeping	CL-3 with high access restriction, extensive training, full isolation
Primary Barriers	Species-appropriate containers		Species-appropriate containers	Escape-proof arthropod containers, glove boxes, BSC	Escape-proof arthropod containers handled in cabinet or suit laboratory
Secondary Barriers			Separated from laboratories, double doors (2), sealed electrical/plumbing openings. Breeding containers and harborages minimized.	CL-3	CL-4

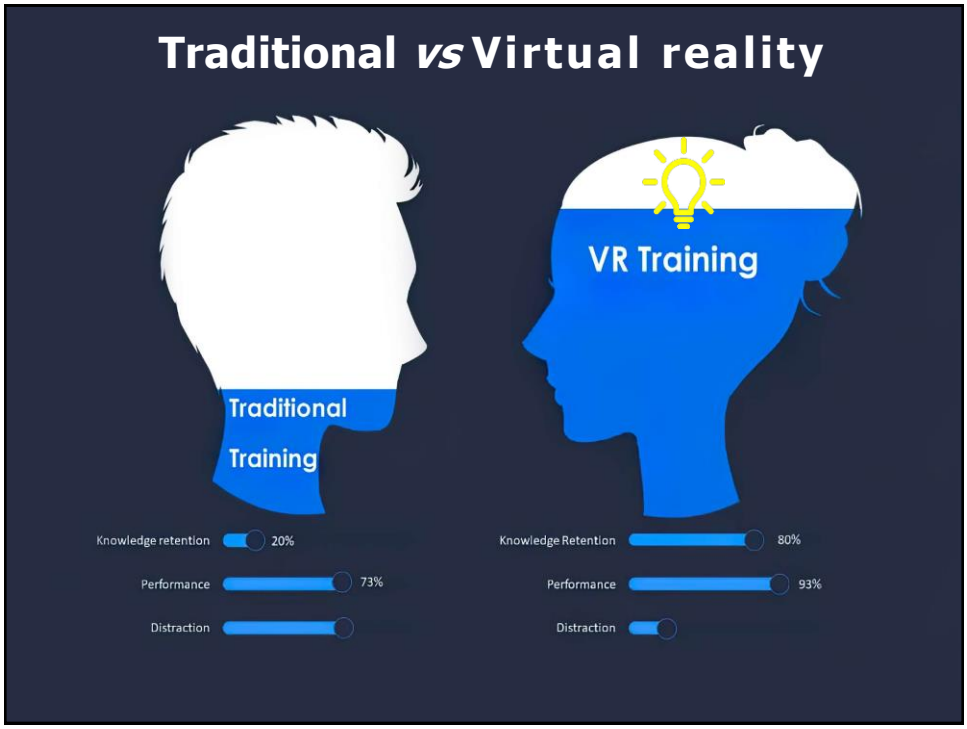
Source: Arthropod Containment guidelines (version 3.1). The American Committee of Medical Entomology of the American Society of Tropical Medicine and Hygiene

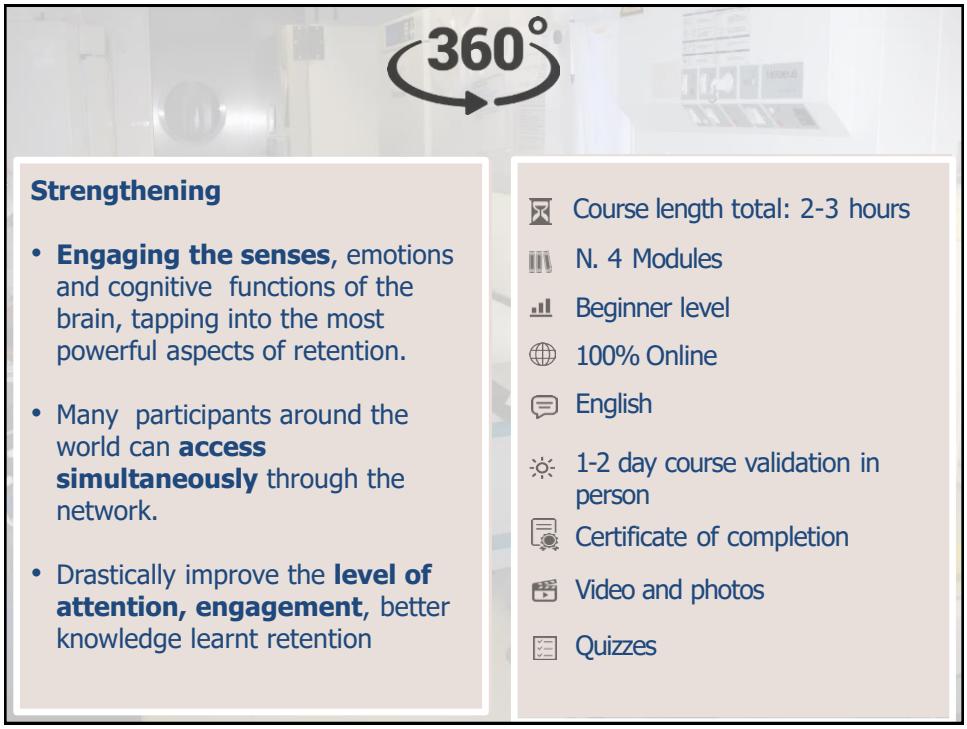
Summary of Arthropod Containment Levels (CL)

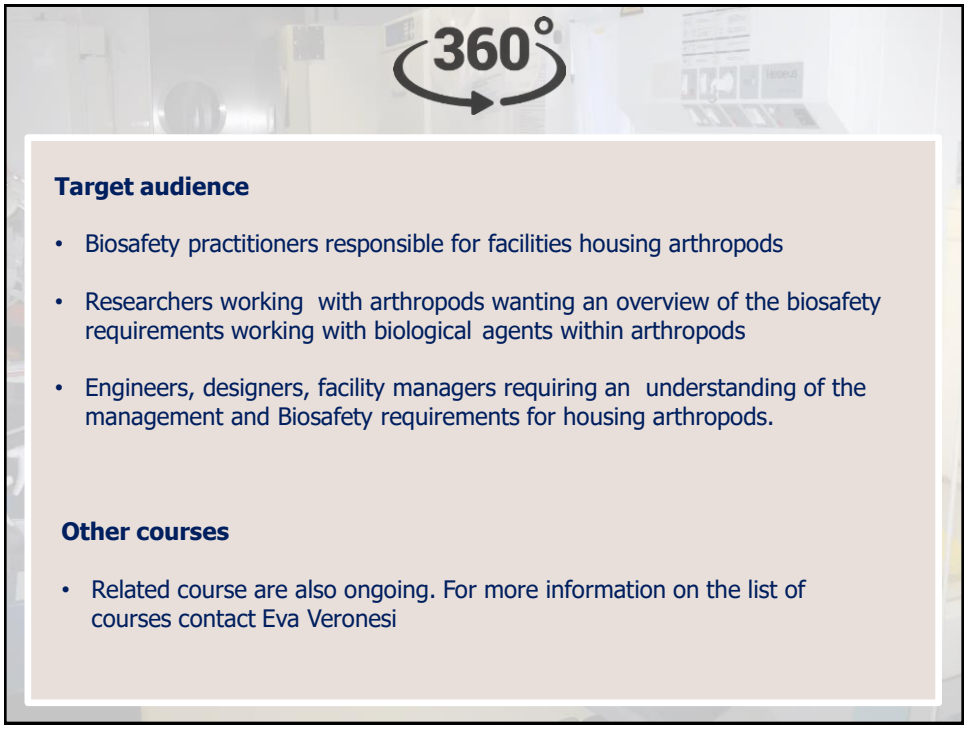
Virtual course "Handling infected arthropods under biocontainment laboratory with BSL3"


BIOSAFETY FOR RG3 PATHOGENS CONTAINMENT
AND
HANDLING OF INFECTED ARTHROPODS
Introducing a new method of e-learning and e-training
using an immersive virtual reality tool
360°


360°
Course description and goals
This course will provide good practice and insights into the assessment of risk, design, operation and management of biocontainment (CL3/BSL3) bound to safety run activities involving risk group 3 (RG3) and handling of infected arthropods.
Specifically, the course here presented includes mosquito arthropods and is the first of a serial of courses targeting different pathogens, vectors and hosts.
Learning objectives
Identify and understand the biohazards and risk associated with rearing arthropods.
Understand the factors related to animal/human health, and environmental protection, to be considered when designing and/or assessing the safety of a facility used to rear arthropods as well as any associated pathogens they may carry.
Infection of arthropods with RG3 pathogens in accordance with biosecurity regulation.
Get a practical view on the operation and management of such facilities including the management of waste, and the response to incidents and emergencies.


Traditional vs Virtual reality
Traditional
Training
VR Training
Knowledge retention
20%
Performance
73%
Distraction
Knowledge Retention
80%
Performance
93%
Distraction


360°
Strengthening
• Engaging the senses, emotions and cognitive functions of the brain, tapping into the most powerful aspects of retention.
• Many participants around the world can access simultaneously through the network.
• Drastically improve the level of attention, engagement, better knowledge learnt retention
Course length total: 2-3 hours
N. 4 Modules
Beginner level
100% Online
English
1-2 day course validation in person
Certificate of completion
Video and photos
Quizzes



Target audience

- Biosafety practitioners responsible for facilities housing arthropods
- Researchers working with arthropods wanting an overview of the biosafety requirements working with biological agents within arthropods
- Engineers, designers, facility managers requiring an understanding of the management and Biosafety requirements for housing arthropods.

Other courses

- Related course are also ongoing. For more information on the list of courses contact Eva Veronesi

Structure of the course

MODULE I: Access, operation and management of biocontainment

- Get a practical view on the operation and management of BSL3 facilities related to arthropod infection and incubation (e.g., waste management, response to incidents and emergencies).

MODULE II : Mosquito infection with RG3 pathogens

- Practicing the infection of arthropods with animal and human pathogens in accordance with biosecurity regulations.

MODULE III : Mosquito dissection and saliva collection

- Practicing the dissection of mosquitoes' body parts including saliva collection.

MODULE IV : Homogenisation and preparation of samples

- Preparation of samples for pathogen quantification via molecular and cell based assays.

Welcome to the virtual course

Click here

Enjoy it!

Thank you for your attention

Eva Veronesi
eva.veronesi@uzh.ch
eva.veronesi@outlook.com