

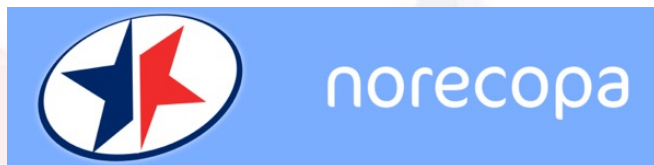
NORINA:

**Models and simulators that can replace (or supplement)
the use of live animals in education**

norecopa.no/SUND

Adrian Smith

adrian.smith@norecopa.no

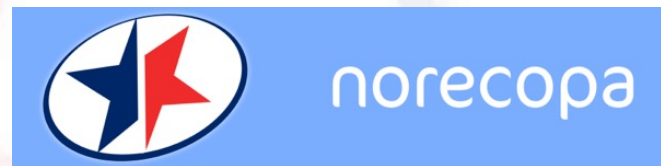


<https://norecopa.no>

Norecopa: PREPARE for Better Science

Norecopa

Norway's National Consensus Platform for the
Three Rs: Replacement, Reduction and Refinement
and a source of global 3R resources



<https://norecopa.no>

Norecopa: PREPARE for Better Science



I was responsible for the Laboratory Animal Unit at the Norwegian School of Veterinary Science in the 1990s when the use of mice, rats, frogs and guinea-pigs in preclinical physiology and pharmacology classes was hotly debated.

animal activists



tutors &
students



lab animal technicians

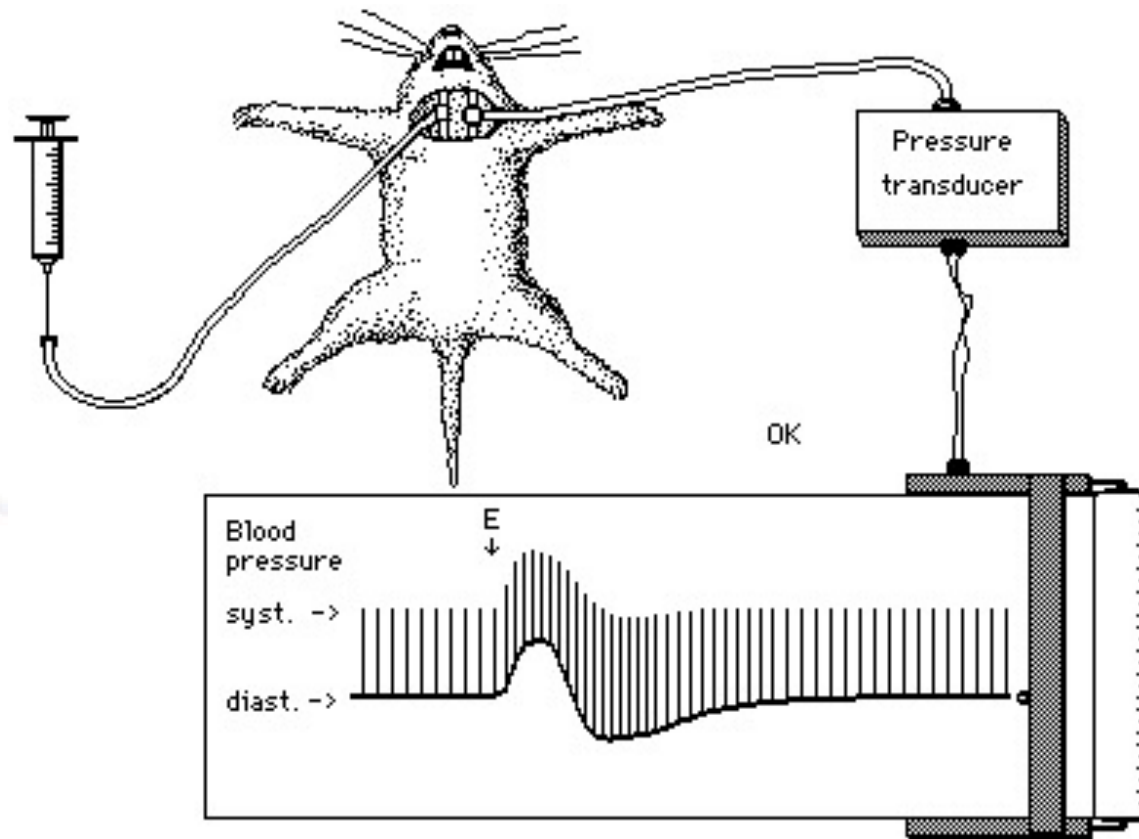
responsible person at the facility



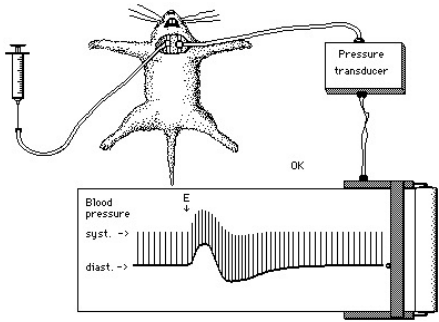
Regulators



Harm-Benefit Assessment



Pharmatutor
Daniel Keller, ETH Zurich
1987



1991-: NORINA database

Richard Fosse
Karina Smith
Elisabeth Pagels



Laboratory Animals Ltd

Norecopa: PREPARE for Better Science



Doubt:

‘Der kan her sættes spørgsmål ved, om den nødvendige læring ikke i lige så høj grad vil kunne opnås uden brug af dyr.’

In my experience, the tutors were convinced that animal use was the best learning environment for the students, while those against were equally convinced of the opposite.

Student majority views could vary from one class to the next!

Arguments that a practical was a good introduction to surgical technique were in my opinion incorrect.

https://3rcenter.dk/fileadmin/user_upload/Editor/images/Om_Danmarks_3R-Center/Udtalelser/Brug_af_dyr_i_undervisning-_til_offentliggørelse_paa_hjemmeside.pdf

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Council of Europe Convention (ETS123), 1986:

Article 25, point 3:

*Procedures shall be restricted to those absolutely **necessary** for the purpose of the education or training concerned and permitted only if their **objective** cannot be achieved by **comparably effective** audio-visual or other suitable methods.*

Choose your teaching objectives!

You can't decide whether or not there is an alternative until you know the aim of the experiment.



Teaching

- laboratory skills
 - preparation-specific animal skills
 - general animal handling skills
- imparting good ethical thinking
 - data handling skills
 - experimental design skills
 - communication skills (oral, written)
 - group work
 - staff-student interaction

EU Directive 2010/63



Article 1:

This Directive establishes measures for the protection of animals used for scientific or **educational** purposes.

Article 5:

Procedures may be carried out for the following purposes only:
... **higher** education, or training for the acquisition, maintenance or improvement of vocational skills;

Recital 12:

The use of animals for scientific or educational purposes should therefore only be considered where a non-animal alternative is **unavailable**.



Russell & Burch: The Principles of Humane Experimental Technique (1959)

- Replacement
- Reduction
- Refinement

'We may need the animals, as it were, on the night; but the machines will do very well at rehearsals'

"Alternatives" may be too poor to replace animals totally, but may be excellent as briefing or debriefing aids:

Make your worst mistakes on an inanimate object, not a living animal!



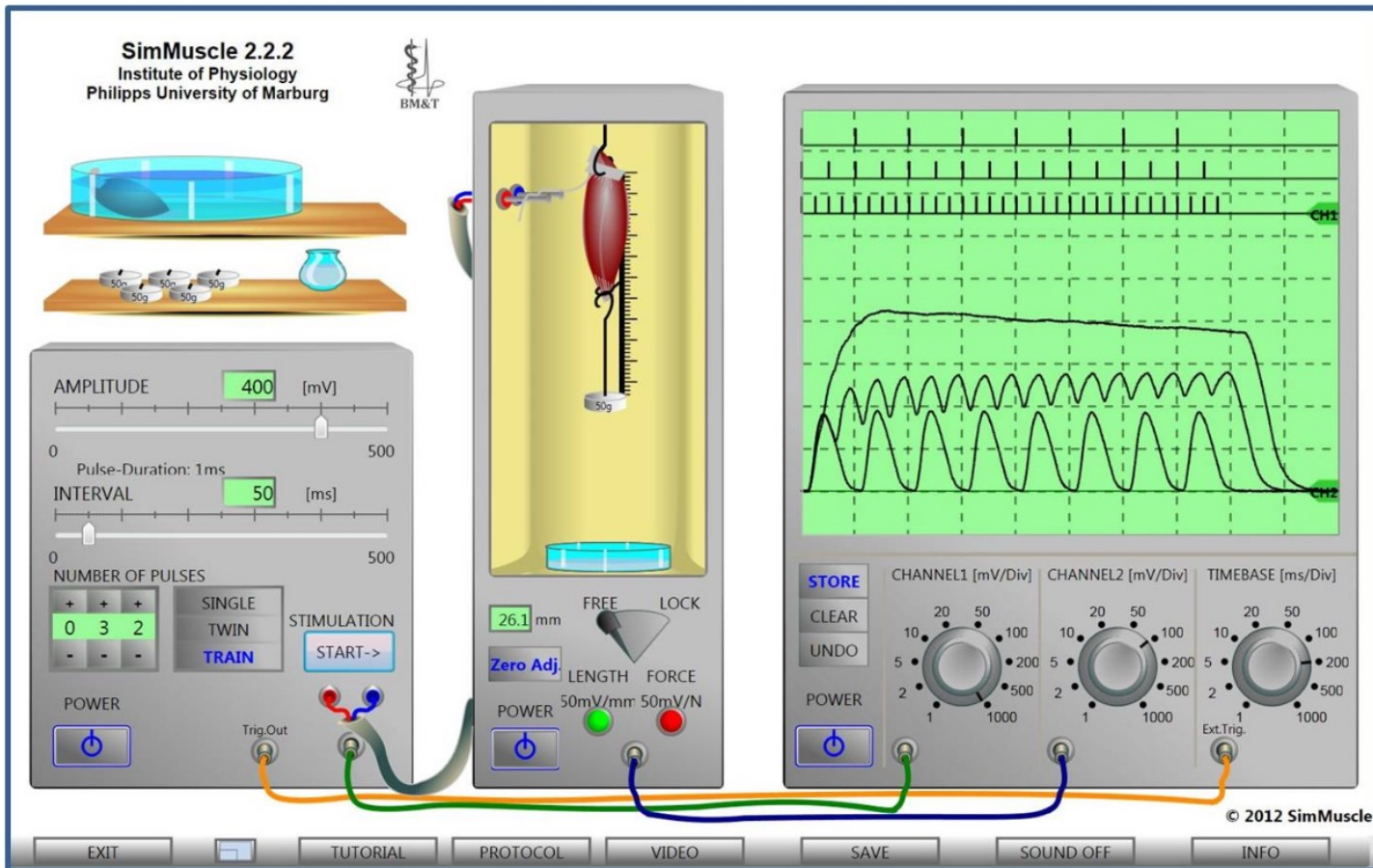
No doubt:

‘Ud over frøene som brukes til selve undervisningen, er der et stort antal frøer, der mister livet – både under transporten til Danmark og i forbindelse med den efterfølgende opstaldning’.

https://3rcenter.dk/fileadmin/user_upload/Editor/images/Om_Danmarks_3R-Center/Udtalelser/Brug_af_dyr_i_undervisning-_til_offentliggoerelse_paa_hjemmeside.pdf

Norecopa: PREPARE for Better Science

SimMuscle 2.2.2
 Institute of Physiology
 Philipps University of Marburg



The interface includes a control panel on the left with the following settings:

- AMPLITUDE: 400 [mV]
- Pulse-Duration: 1ms
- INTERVAL: 50 [ms]
- NUMBER OF PULSES: 0 3 2 (with '+' and '-' buttons)
- STIMULATION: SINGLE, TWIN, TRAIN (with 'START->' button)
- POWER: (power button)

The central panel shows a virtual muscle with a 50g weight and a 26.1 mm length. It includes a 'Zero Adj.' knob and 'FREE'/'LOCK' buttons. The right panel is a dual-channel oscilloscope showing:

- CHANNEL 1: A square wave pulse train.
- CHANNEL 2: A series of action potentials corresponding to the pulses.
- TIMEBASE: 20 ms/Div
- CHANNEL 1 scale: 20 mV/Div
- CHANNEL 2 scale: 20 mV/Div

© 2012 SimMuscle

SimMuscle

Hans Braun, Marberg virtual-physiology.com

The tutor loses control over the content...



Guinea Pig Ileum

By David Dewhurst; Philip Larkman and Stewart Cromar

Record number: 5830d (legacy id: 855)

Category: [Pharmacology](#)

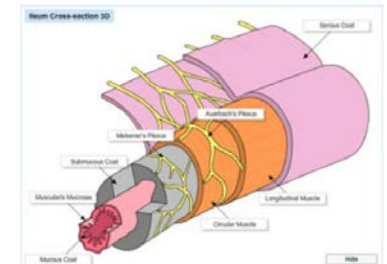
Type: [Computer Program](#)

A computer simulation program to teach the effects of drugs and electrical stimulation on the enteric nervous system. Type of record: Computer Program. Category: Pharmacology (animal).

A computer simulation program to teach the effects of drugs and electrical stimulation on the enteric nervous system.

This program simulates an isolated preparation of the guinea pig ileum, a smooth muscle preparation exhibiting little spontaneous contractile activity, which is extensively used for pharmacological studies. Its aim is to enable the exploration of the effects of drugs and electrical stimulation on the release of, and response to, neurotransmitters in the enteric nervous

system. Simulated responses are derived from a model which presents the contractile response of the ileum both to added drugs and to transmural electrical stimulation. Learning is through exploration and the program places at the disposal of the user a range of DRUGS (acetylcholine, histamine, clonidine, morphine, naloxone, phentolamine, atropine, mepyramine) which may be added alone or in combination to the organ bath in a range of DOSES, and an electrical STIMULATOR. A 'magic' WASH facility instantly removes all traces of added drugs and greatly speeds up the process of data collection compared to the real experiment. Simulated contractions of the gut are presented on a scrolling display comparable to that of a chart recorder. Students may take measurements directly from the monitor.



The tutor cannot decide the drugs to be used

norecopa.no/NORINA 3,000 alternatives/supplements to animal use



Frog Dissection

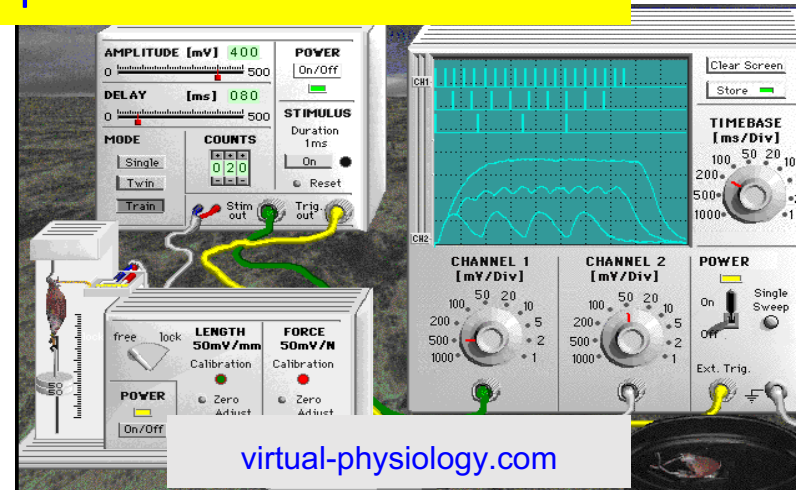
In-store Educational Discount Available

Virtual Frog Dissection Educational App

The Frog Dissection App is an ethical and educative alternative to live animal dissections. Help your students learn all about frogs and their biological functions, without the messy lab work or controversial questions

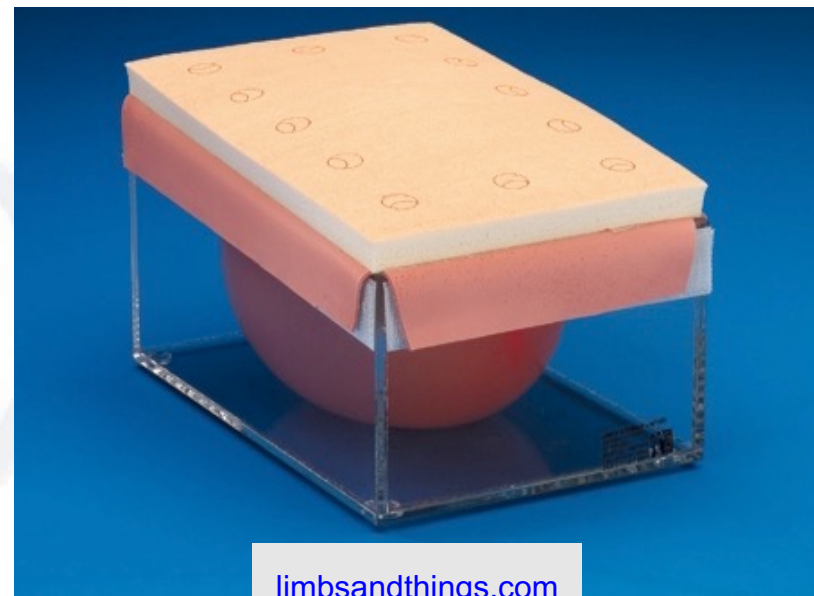
app screens
Click to view

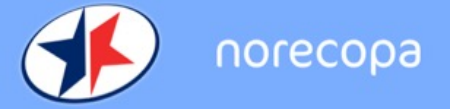
frogvirtualdissection.com



AMPLITUDE [mV] 400
DELAY [ms] 080
MODE: Single, Twin, Train
COUNTS: 0 2 0
POWER: On/Off
STIMULUS: Duration 1ms, On, Reset
CHANNEL 1 [mV/Div]: 100, 50, 20, 10, 5, 2, 1
CHANNEL 2 [mV/Div]: 100, 50, 20, 10, 5, 2, 1
TIMEBASE [ms/Div]: 100, 50, 20, 10, 5, 2, 1
POWER: On, Single Sweep, Ext. Trig.

virtual-physiology.com






TextBase:

1,500 books

norecopa.no/textbase

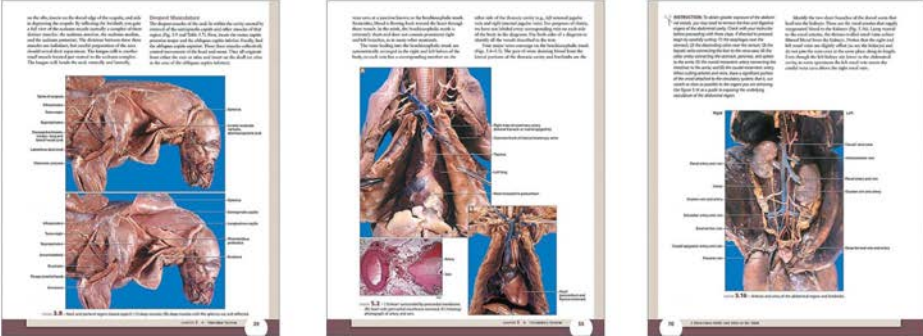
Home > Life Sciences > Biology > Dissection Guides > A Dissection Guide & Atlas to the Mink, 2e



A Dissection Guide & Atlas to the Mink, 2e
By David G. Smith, Michael P. Schenk • © 2020 • 136 Pages
Loose-leaf Format • Print ISBN 9781640430525 • eBook ISBN 9781640430532

This full-color dissection manual is intended to provide an introduction to the anatomy of the mink for biology, zoology, nursing, or preprofessional students who are taking a laboratory course in anatomy and physiology or basic vertebrate anatomy.

Examples of interior pages:



Suggested Student Retail Price
\$36.00

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<https://www.morton-pub.com/product/a-dissection-guide-atlas-to-the-mink-2e>

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norecopa.no/education-training/films-and-slide-shows



Rat s.c. injection
Norecopa | 1,380 views



Testing anaesthetic depth in the chicken
Norecopa | 598 views



Blood sampling from the pig
Norecopa | 3,914 views



Subcutaneous injection in the rabbit
Norecopa | 1,479 views



Rat i.p. injection (method 2)
Norecopa | 1,280 views



Blood collection from the saphenous vein in the mouse
Norecopa | 6,777 views



Blood sampling from the pig
Norecopa | 3,914 views



Subcutaneous injection in the chicken
Norecopa | 1,806 views

ANATOMÍA DE LA RATA

Dra. Dolores Vallejo Ruiz
Departamento de Biología de Sistemas, Universidad de Alcalá (Madrid)

Asesoría Científica: Dr. José María Orellana Moriana
Centro de Experimentación Animal, CAI Medicina-Biología, Universidad de Alcalá

Anatomía de la rata
Norecopa | 977 views



Subcutaneous injection in the rat - Technique 1
Norecopa | 2,249 views



Lifting a rabbit
Norecopa | 2,420 views



Immobilisation of the rabbit
Norecopa | 2,072 views

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Hen:

[Handling and blood sampling; s.c. injection and cardiac puncture](#)

Mink:

[i.v. injection](#)

[Blood sampling from the saphenous vein](#)

Mouse:

[Blood sampling from the saphenous vein](#)

[Immobilisation and blood sampling from the saphenous vein \(NB older method of handling\); i.p. injection; s.c. injection and oral gavage](#)

[Links to other resources](#)

[Housing, handling and training mice at RISE](#) ([Research Institutes of Sweden](#)) - includes refinement of oral gavaging, saphenous venepuncture of mice and blood sampling from the tail of mice and rats (see also their film [Refinement work at RISE](#))

[Intravenous injections](#)

[Refinement of the scruffing technique](#)

[Refinement of mouse handling - video clips](#) (NC3Rs webpage)

[Refinement of mouse handling](#) (NA3RsC webpage)

[Handling techniques to reduce stress in mice](#) (Marcotte *et al.*, 2021; JOVE video)

[Mouse handling posters](#) (NC3Rs), A2 size, for display in animal facilities (English, Chinese, French, German, Spanish & Greek)

Webinar: [Mouse handling made easy - Reducing anxiety in mice and their handlers](#)

[Advice on rodent housing](#) from NA3RsC

[Oral gavage training](#) (Instech)

[Automated blood sampling](#) (Instech)

[Videos of anaesthesia, blood pressure measurements, oximetry and warming of rodents](#), by Kent Scientific

[Online Refined Mouse Handling Course](#) (3RsC & NC3Rs)

Pig:

[Blood sampling techniques \(Framstad *et al.*\)](#)

[Immobilisation and blood sampling](#)

[Links to other resources:](#)

[Pig blood sampling](#) (NC3Rs)

[Pig handling and housing](#) (NC3Rs)

O'Malley *et al.* (2022): [Refining restraint techniques for research pigs through habituation](#)

The [Panepinto Sling](#) for minipigs and other animals up to 150 kg

[Handling, Dosing and Training of the Göttingen Minipig](#)

[Ellegaard Göttingen Minipigs Science Base](#)

Panepinto (2020): [Prioritizing humane minimum-stress methods in swine facility and protocol design](#)

norecopa.no : "an up-to-date overview of global 3R resources"

The screenshot shows the norecopa.no website interface. At the top, there is a blue header with the norecopa logo (a stylized star) and the text "norecopa". Below the header is a navigation menu with links: "About Norecopa", "Alternatives", "Databases & Guidelines", "Education & training", "Legislation", "Meetings", "More resources", "News", and "PREPARE".

Below the navigation menu, there is a list of categories: "Anaesthesia and analgesia", "Animal facilities", "Animal welfare organisations", "Blood sampling", "Culture", "Email discussion lists", "Environmental enrichment", "Ethics", "Experimental design and reporting", "Harmful", "Health and safety", "Health monitoring", "Humane", "Literature searches and systematic reviews", and "Organisations".

In the center, there is a text box with the following information:

- 10,100 webpages
- approx. 1,000 hits daily
- 7-8 detailed newsletters per year

On the right side, there is a "Search filters" panel with the following sections:

- Search filters**
- Order by: Relevance (dropdown)
- Typo tolerance: Default (dropdown)
- Database** (dropdown menu)
- 3R Guide database (403)
- Classic AVs database (118)
- European Commission Inventory of 3Rs Education & Training Resources (567)
- European Commission Inventory of 3Rs Knowledge Sources (807)
- European Commission Inventory of NAMs for Respiratory tract diseases (280)
- NAL records (1688)
- NORINA database (3141)
- TextBase database (1501)
- Website (761)
- Browse the databases** (dropdown menu)
- eBooks (286)
- Free (199)
- Held at NMBU Oslo (contact Kristine Hansen, 67 23 21 89) (431)
- Key products (68)
- On loan (6)
- Reviewed (85)
- Search in the databases** (dropdown menu)
- All Text (selected)
- Title
- Author
- Publisher
- Supplier
- Record Number

At the bottom of the page, there is a section titled "Design and reporting of animal experiments" with the following text:

This page supplements advice given in [Section 4 of the PREPARE guidelines](#). PREPARE covers all aspects of design (including animal and facility related issues).

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There are submenus under all the headings above

Current number of pages : 9464

228 results

Rat Blood Pressure

NORINA database/af1a4 (legacy id: 4447)

An interactive computer simulation of experiments to study the effects of a number of pharmacological agents on rat blood pressure in vivo . Type: Computer Program. Category: Pharmacology (animal) & Physiology (animal).

Author: [Ian E. Hughes](#) [David Dewhurst](#) and [Alan Williams](#)

Supplier: [Sheffield BioScience Programs](#), [Dr. David Dewhurst](#)

A refined method of repeated blood sampling in mice

NAL records/b2d28 (legacy id: 3828971)

Journal: Animal technology : journal of the Institute of Animal Technicians,

Author: [Kitching, A.](#)

Search filters

Order by:

Typo tolerance:

Database

- 3R Guide database (12)
- Classic AVs database (6)
- European Commission Inventory of 3Rs Education & Training Resources (19)
- European Commission Inventory of 3Rs Knowledge Sources (1)
- European Commission Inventory of NAMs for Cardiovascular diseases
- European Commission Inventory of NAMs for Respiratory tract diseases
- NAL records (49)
- NORINA database (38)
- TextBase database (42)
- Website (61)

Category

- 3R Center (1)
- Agricultural animals (3)
- Anaesthesia (1)
- Anaesthesia and analgesia (2)
- Anatomy (6)
- Aquatic animals (2)
- Behaviour
- Behavioural research (2)
- Biochemistry (3)
- Biology
- Birds (3)
- Blood sampling (6)
- Cancer research (2)
- Design (4)
- Disease research (3)
- Dissection
- Education and training (4)

Type

- App
- Audio Tape
- Book
- CD-ROM (5)
- Chart/Diagram (1)
- Computer Program (4)
- Contact Person
- Databases
- Discussion forums
- Display Mounts (1)
- DVD (8)
- Film
- Filmstrip
- Guidelines (11)
- Information centres (2)
- Journals
- Microslides (4)
- Miscellaneous
- Model



Workshop in 2018: norecopa.no/education-training/homemade-educational-materials

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norecopa



Norec



norecopa.no/media/8099/langebæk.pdf

Simulation and Clinical Skills at University of Copenhagen

Rikke Langebæk
Associate professor, DVM, PhD
Department of Veterinary Clinical Science
Faculty of Health Sciences

UNIVERSITY OF COPENHAGEN



Oslo, April 2018 17



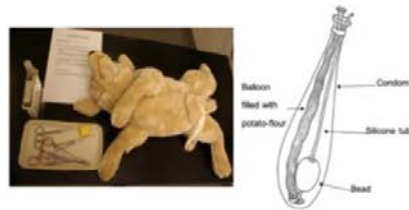
Figure of Eight Ligature



Record number: bf05e
Category: [Surgery](#)
Type: [Simulator](#)

This model uses a stuffed toy dog with a "vaginal tunic" (condom), a "pampiniform plexus" (balloon with corn flour) and a "ductus deferens" (silicone tube) placed in the "prescrotal" area.

This model uses a stuffed toy dog with a "vaginal tunic" (condom), a "pampiniform plexus" (balloon with corn flour) and a "ductus deferens" (silicone tube) placed in the "prescrotal" area.



Assignment:

Using a needle and suture, a figure of eight ligature is placed through the *tunica vaginalis*, encircling the ductus and the plexus respectively.

Materials:

- > A stuffed toy dog. The dog is equipped with a metal clip in the prescrotal area. The clip is covered with a piece of "skin/fur" – a flap - that permits access to the clip from the cranial as well as the caudal side
- > Plexus pampiniformis: a long balloon (20cm) filled with corn starch
- > Ductus deferens: a rubber tube (diameter 3mm) from a bicycle shop
- > Tunica vaginalis: a plain condom, regular
- > Testicle: a wooden bead, 4 x 2.5 cm
- > Tape

norecopa.no/norina/figure-of-eight-ligature

Fidelity and Discrimination



<https://syndaver.com>

High Fidelity, Low Discrimination



Rikke Langebæk, University of Copenhagen

Low Fidelity, High Discrimination

The 3Rs in microsurgery training



PROFESSOR MICHAEL AXELSSON

Department of Biological and Environmental Sciences, Box 463, SE-405 30
Gothenburg, Sweden

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E-mail: michael.axelsson@gu.se

Web: http://www.bioenv.gu.se/personal/Axelsson_Michael/

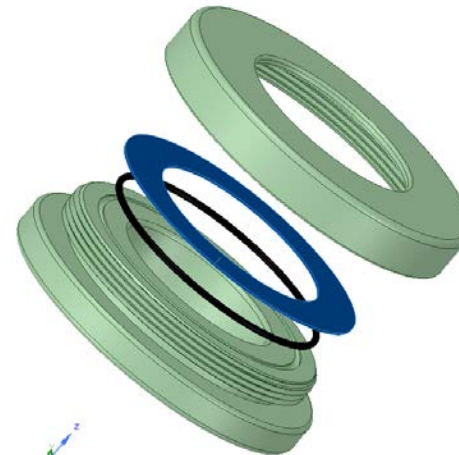
First instrument suturing

Banana peel is useful



Sun-Lee disk in a modern 3D printed design

Suturing in latex membrane




norecopa.no/education-training/homemade-educational-materials



Norecopa: PREPARE for Better Science

The book cover is framed by a double-line red border. At the top center is a circular logo with a large red '3' in the center, the letters 'T' and 'R' on either side, and the text 'UNIVERSITY CENTER FOR ANIMAL RESOURCES AND EDUCATION AT CORNELL UNIVERSITY' around the perimeter. Below the logo, the title 'Translational Training Tools™' is written in a bold, black, sans-serif font, with the subtitle 'The 3 Ts Serving the 3 Rs' in a smaller, black, sans-serif font. In the center is a red triangle containing the word 'Joy' in a white, serif font, with 'OF TRAINING' in a smaller, white, sans-serif font below it. Below the triangle, the text 'VOLUME 1' is written in a bold, red, sans-serif font, followed by 'Recipes for Crafting Your Own Purpose-Specific Training Tools' in a red, sans-serif font. At the bottom, the authors' names 'Wendy O. Williams, DVM, DACLAM', 'David E. Mooneyhan, BS, RLATG', and 'Christine M. Peterson, BS, RLATG' are listed in a black, sans-serif font. The URL 'ras.research.cornell.edu/care/3T' is at the very bottom in a red, sans-serif font.



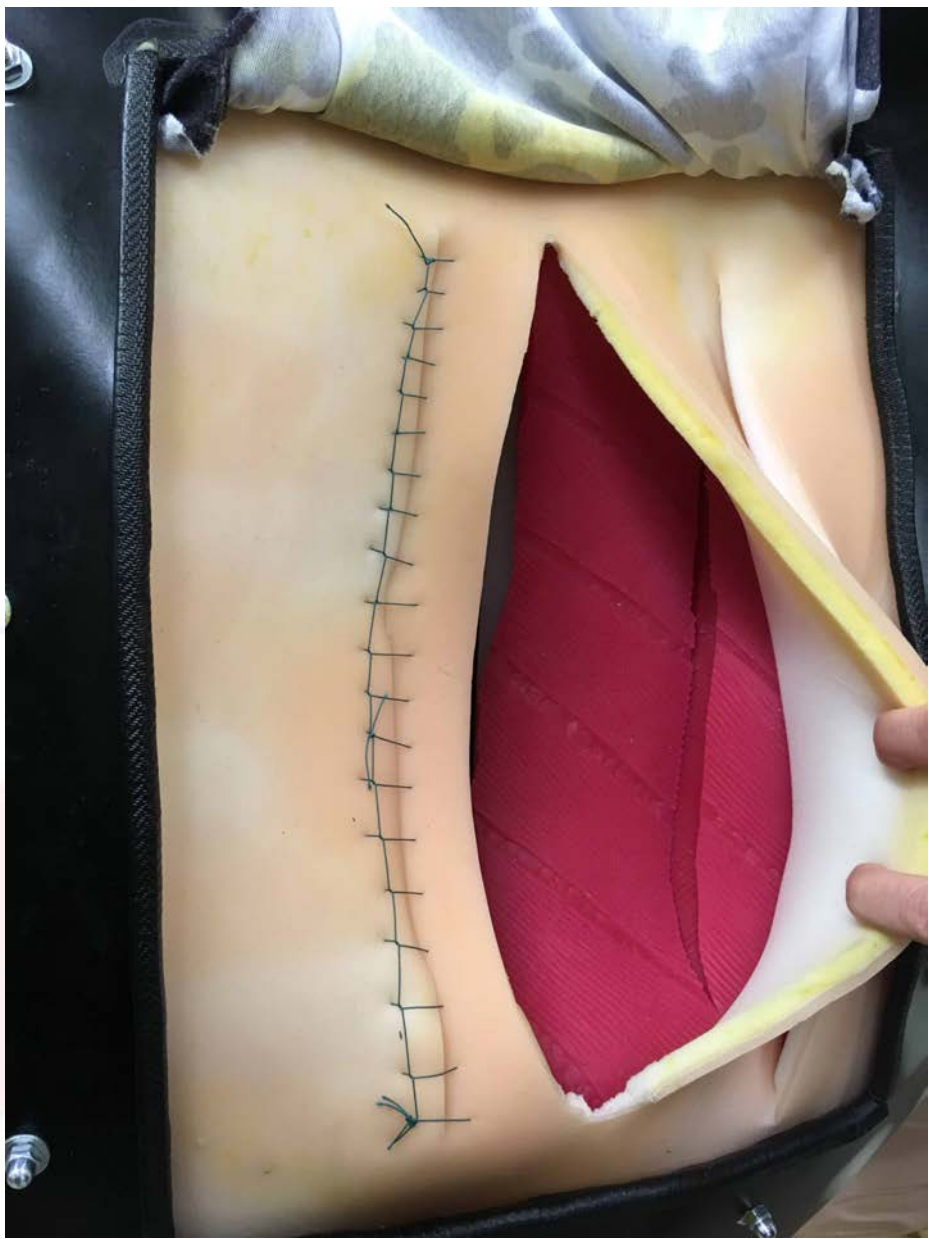
**Development of
veterinary simulators
as an interactive teaching method**

Laura Schüller



C-section simulator





C-section simulator



C-section simulator







Suture skills



Injection skills



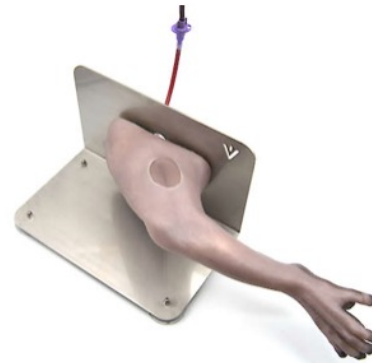
Bones



Gyndog



Castro & Weany



Rita Rhesus

Augmented Reality (AR)

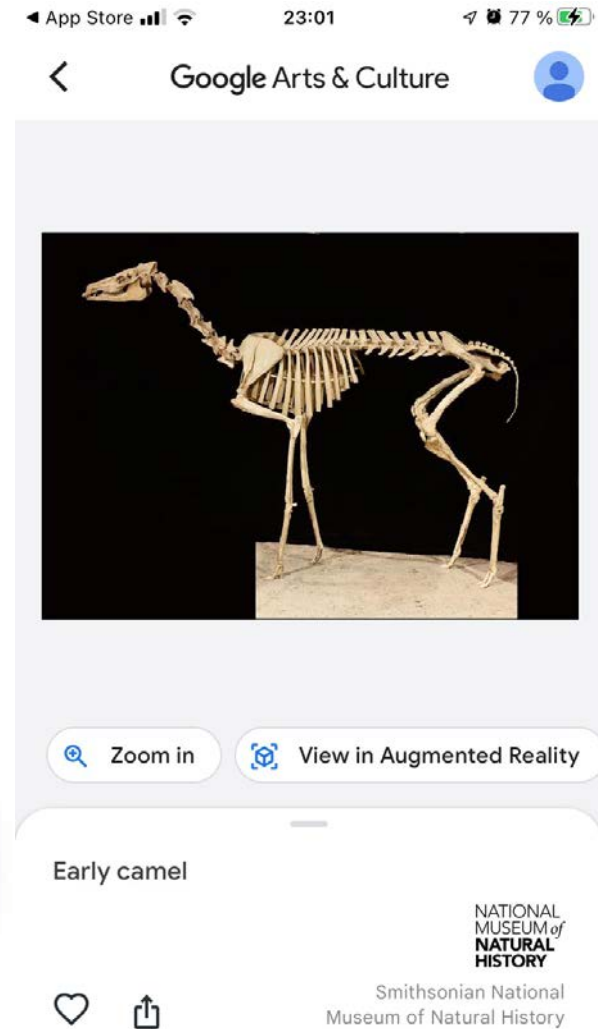
A digital experience superimposed on the real world

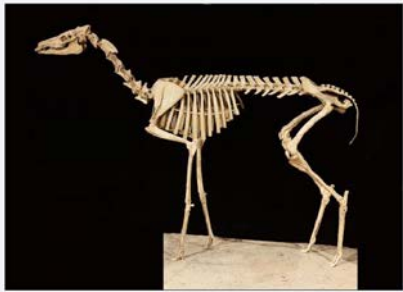
Virtual Reality (VR)

A totally virtual digital world

Google Arts and Culture App

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Zoom in View in Augmented Reality

Early camel



NATIONAL MUSEUM of NATURAL HISTORY
Smithsonian National Museum of Natural History



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3d4medical.com/student



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Virtual Anatomy | Healthcare Simulation |
HealthySimulation.com

Besøk

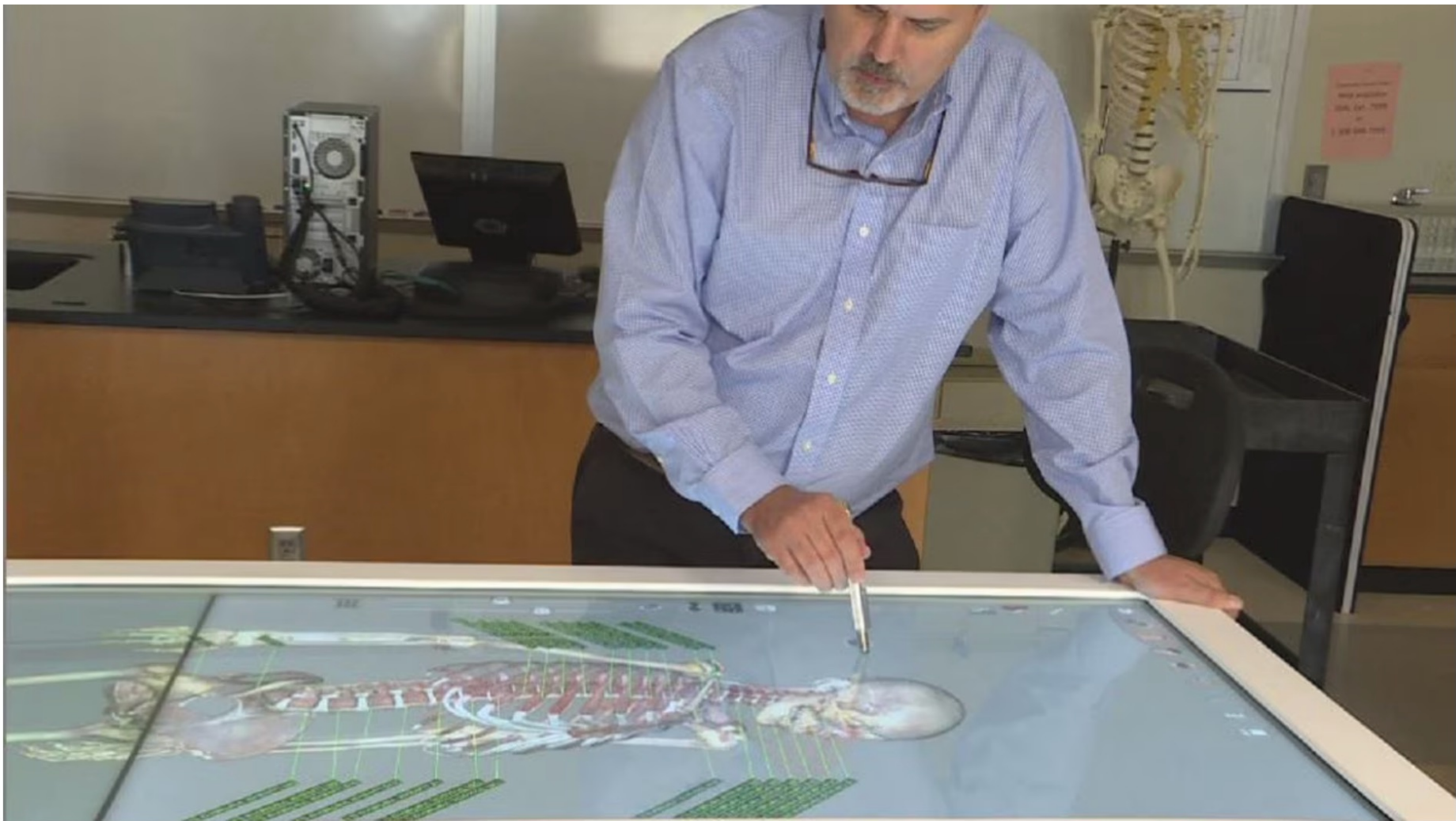
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How Effective is Virtual Reality in Teaching Human Anatomy?



<https://www.ixrlabs.com/blog/how-effective-is-virtual-reality-in-teaching-human-anatomy/>

1. Using VR for complex organs can be disorienting and frustrating.
2. Students could also feel cybersickness, blurry vision and feel disoriented.
3. The cost of VR will have to be considered while applying it in medical colleges.

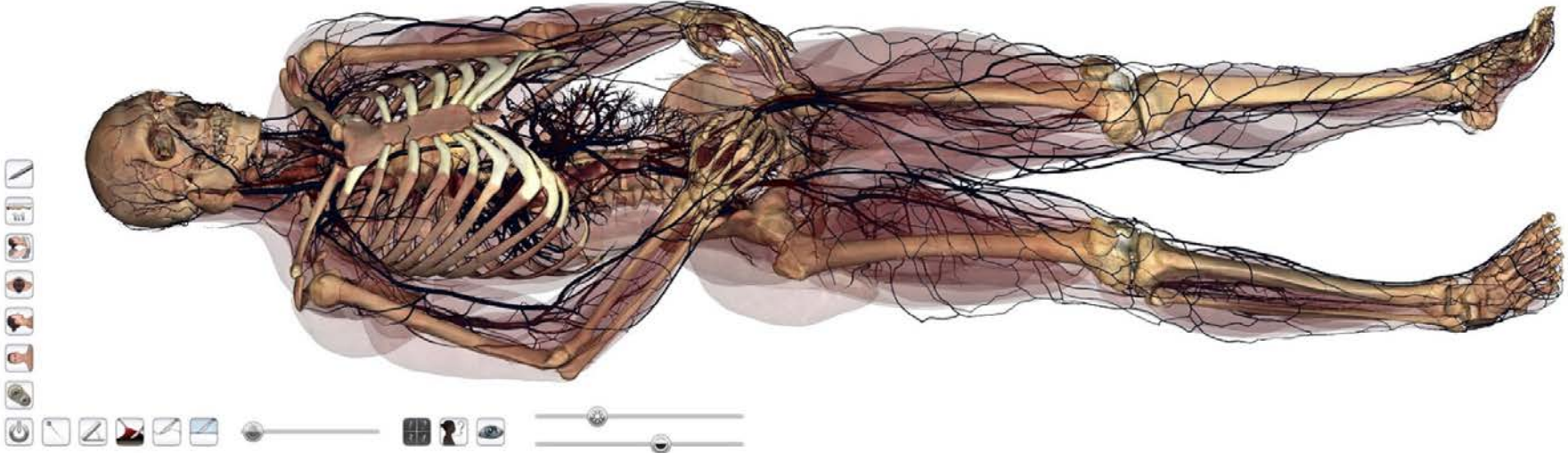


Central Community College - Grand Island instructors introduces Anatomage Table to their biology students. (Hailey Mach, KSNB)

<https://www.ksnlocal4.com/2021/09/28/central-community-college-adds-anatomege-table-biology-classroom>

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anatomage.com



Full Body Sample

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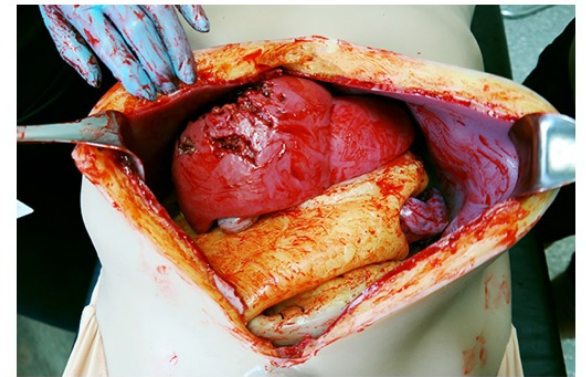
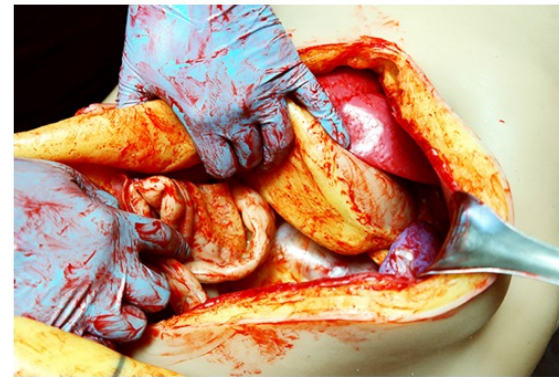
anatomage.com



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Trauma suits worn by actors





Hyper-Realistic® Training

Learn More

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<https://www.strategic-operations.com>

Conclusions

- Models are considered useful educational tools prior to live animal surgery*
- Training on models reduces anxiety before live animal surgery**
- Training a skill on a simulator/model increases student self-efficacy (ability to master skills)***
- For training basic skills, the low-fidelity models fulfill their purpose*
- Improved learning outcome
- A more ethical use of research animals

*Langebaek et al, VetRec (2012)

** Langebaek et al, JVME (2012)

*** Langebaek et al, JVME (2015)

English-language newsletters

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+47 41 22 09 49
post@norecopa.no

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Ullevålsveien 68
0454 Oslo


Postal address
% Norwegian Veterinary
Institute
P.O. Box 750 Sentrum
N-0106 Oslo, Norway


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 Norges miljø- og biovitenskapelige universitet

 U.S. Department of Agriculture

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