

Human and animal models for testing immune competence

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Human and animal models

- *(in silico)*
- *in vitro*
- *ex vivo*
- *in situ*
- *in vivo*

- pathological conditions
- absorption
- bacteria-host interactions



In vitro models (1)

In vitro (Latin: *in glass*) studies are those that are conducted using components of an organism that have been isolated from their usual biological surroundings in order to permit a more detailed or more convenient analysis than can be done with whole organisms. Also known as "test tube" or "petri dish" experiments.

Source: Wikipedia

cell cultures



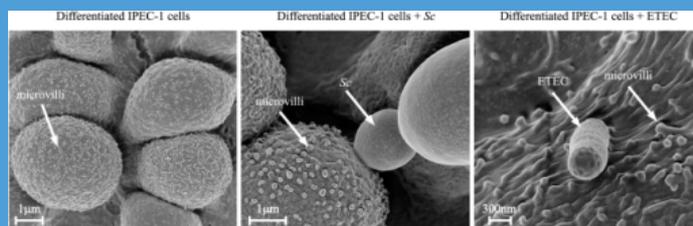
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In vitro models (2)

intestinal cell lines:

- human: HT-29, T84, Caco-2
- rodent: IEC-6, IEC-8
- calf: CIAB
- chicken: B1oxi, B5, B6
- pig: IPEC-1, IPEC-J2, IPI-2I



Source: Zanello et al., 2011



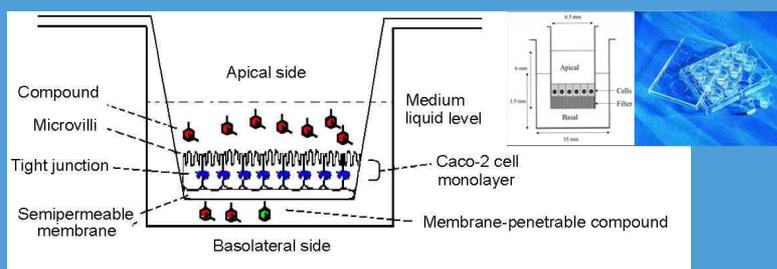
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In vitro models (3)

intestinal cell lines:

- monolayers on plastic surfaces
- 2D cultures: insert filters, Transwell system

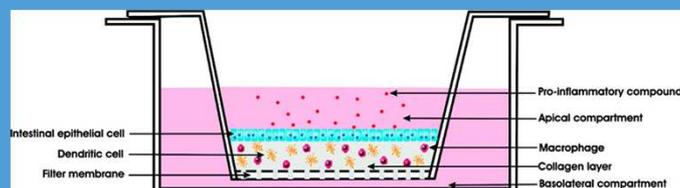


Source: Yang et al., 2007

In vitro models (4)

intestinal cell lines:

- 3D cultures: Caco-2 + macrophages, dendritic cells



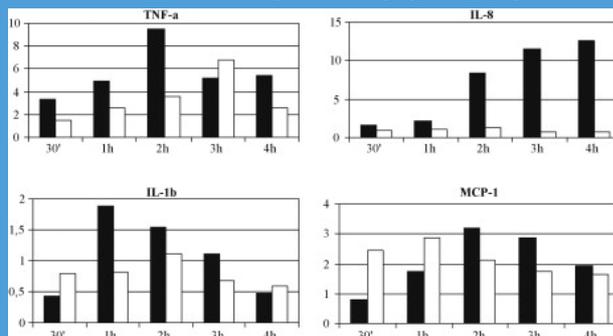
Source: Leonard et al., 2010

- Calf: intestinal epithelial cells (CIAB)
+ bovine macrophages (BOMA)

In vitro models (5)

intestinal cell lines:

- bacteria – cell interactions
- absorption / transport
- immune response by gene expression



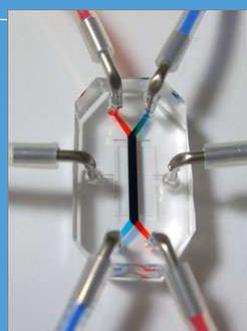
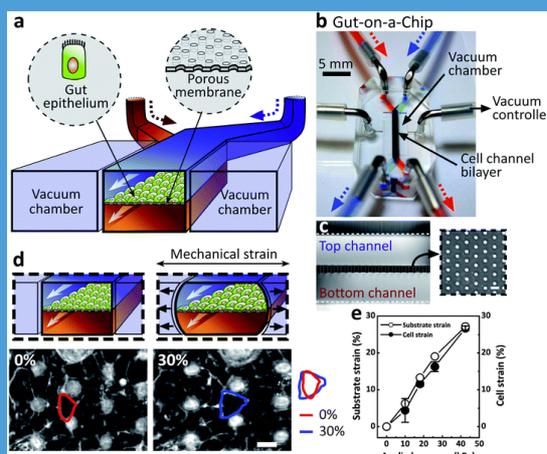
Innate immune activation of swine intestinal epithelial cell lines (IPEC-J2 and IPI-2I) in response to LPS from *Salmonella typhimurium*

Source: Arce et al., 2010



In vitro models (6)

Intestine-on-a-chip

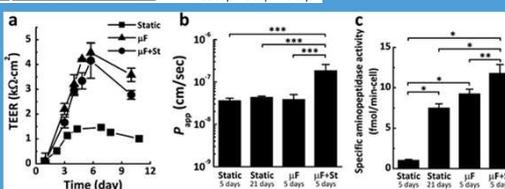
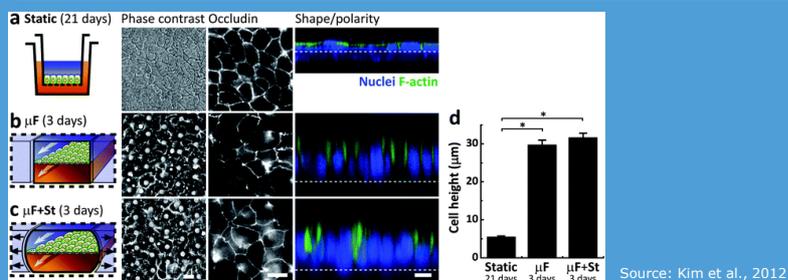


Source: Kim et al., 2012



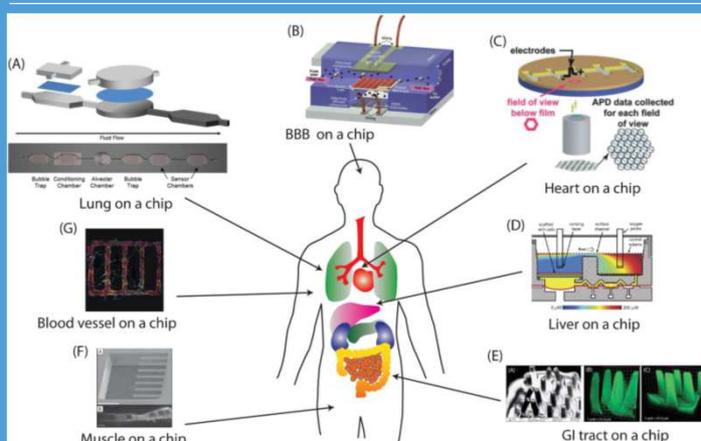
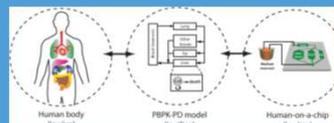
In vitro models (7)

Intestine-on-a-chip



In vitro models (8)

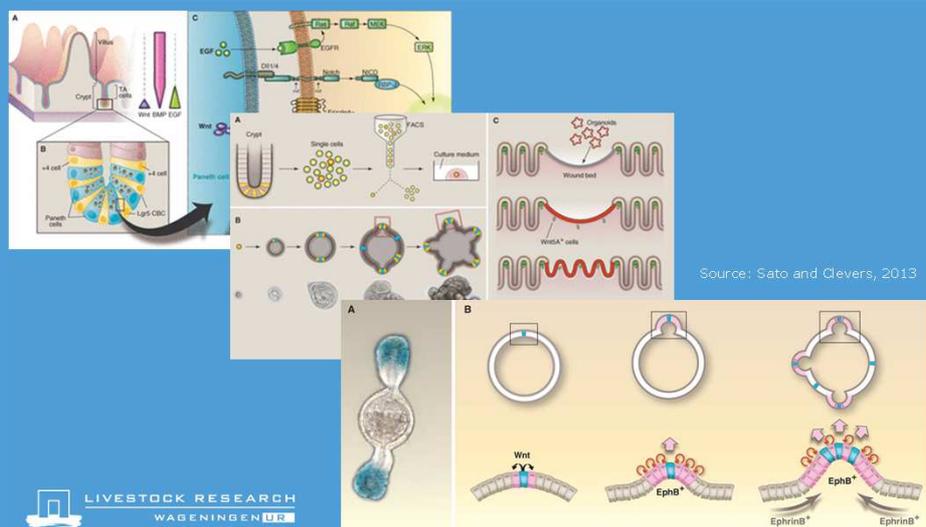
Body-on-a-chip



Source: Sung et al., 2013

In vitro models (9)

Epithelial mini-guts



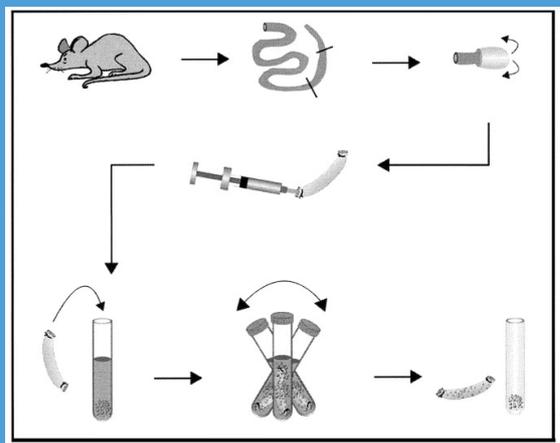
Ex vivo models (1)

- *Ex vivo* (Latin: "out of the living") refers to experiments done in or on tissue in an artificial environment outside the organism with the minimum alteration of natural conditions. *Ex vivo* conditions allow experimentation under more controlled conditions than possible in *in vivo* experiments, at the expense of altering the "natural" environment.

Source: Wikipedia

Ex vivo models (2)

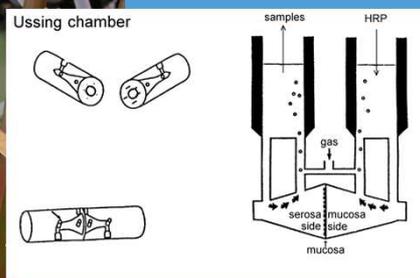
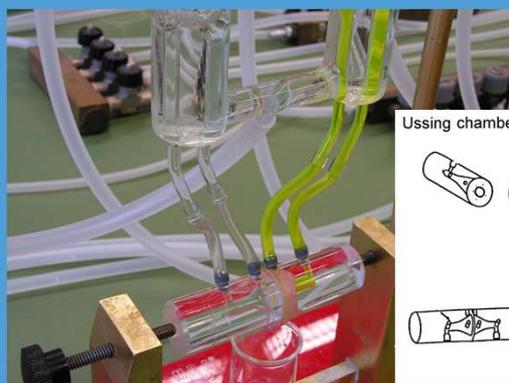
- Everted sac



Source: Santos et al., 1999

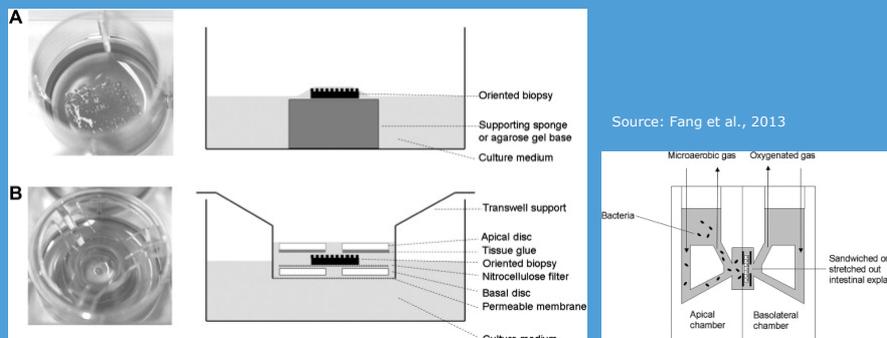
Ex vivo models (3)

- Ussing chamber



Ex vivo models (4)

In vitro organ culture (IVOC) or ex vivo organ culture



Source: Fang et al., 2013

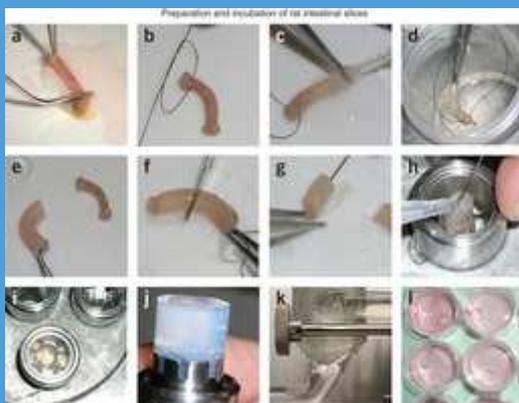
Immune response of porcine intestinal in vitro organ culture tissues following exposure to *Lactobacillus plantarum* and *Salmonella typhimurium*

Source: Collins et al., 2010



Ex vivo models (5)

Precision cut slices (PCTS)



Source: de Graaf et al., 2010



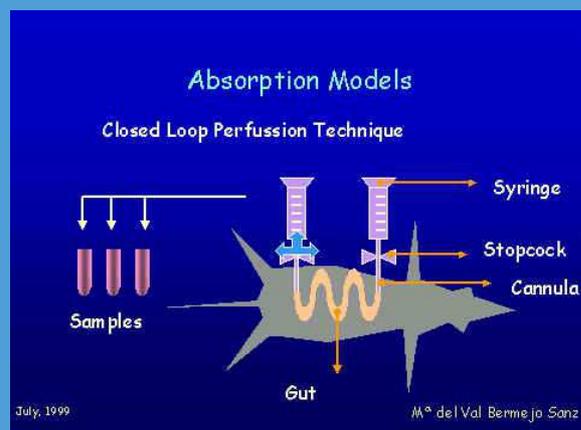
In situ models (1)

In situ (Latin: in position) means to measure exactly in place where it occurs (i.e. without moving it to some special medium). *In situ* models are intermediate between *in vitro/ex vivo* models and *in vivo*.

Source: Wikipedia

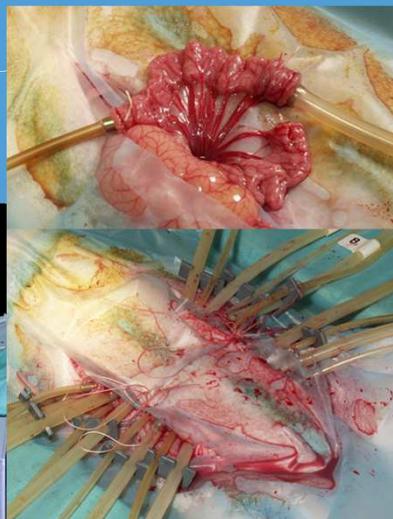
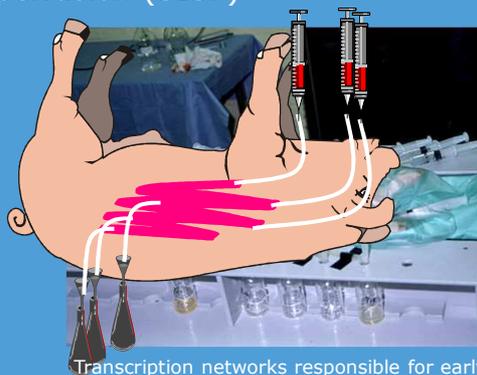
In situ models (2)

Intestinal loop



In situ models (3)

Small intestinal segment perfusion (SISP)



Transcription networks responsible for early regulation of *Salmonella*-induced inflammation in the jejunum of pigs

Source: Hulst et al., 2013

In vivo models (1)

In vivo (Latin for "within the living") is experimentation using a whole, living organism as opposed to an *in vitro* controlled environment or a partial or dead organism. *In vivo* testing is often employed over *in vitro* because it is better suited for observing the overall effects of an experiment on a living subject.

Source: Wikipedia

In vivo models (2)

- Animal models for:
 - Crohn's disease
 - ulcerative colitis

- Pig, chicken, calf:
 - *Salmonella* challenge
 - ETEC challenge

Correlations between models and 'real practice' in humans or monogastrics

- Depends on the question to be answered and the model used.
- Different *in vitro*, *in situ* or *ex vivo* models not always indicate the same.
- Both studies showing a good correlation and studies showing a bad or no correlation between a model and the 'real practice' of monogastrics have been published.



- Thorough literature research (systemic review?) needed before testing functional components.

Questions

- Is there a best model?
 - advantages and disadvantages of each model
- What about *in silico* modelling for immune competence?

Thank you for
your attention

