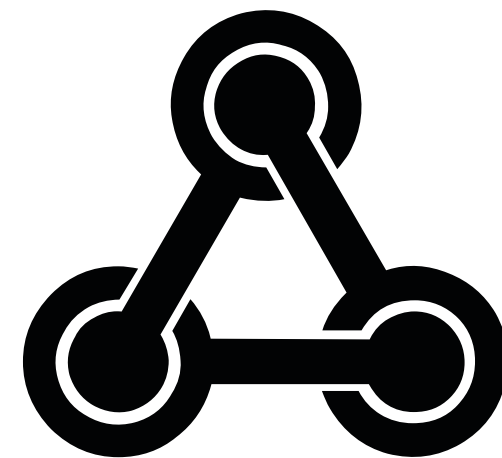


# **Creative Connections Bodylight**

illuminating the function of the human body

Technology to combine biomedical research, graphical design and  
mathematical modeling

Enabling the creation of interactive in-browser simulators



**Creative Connections**



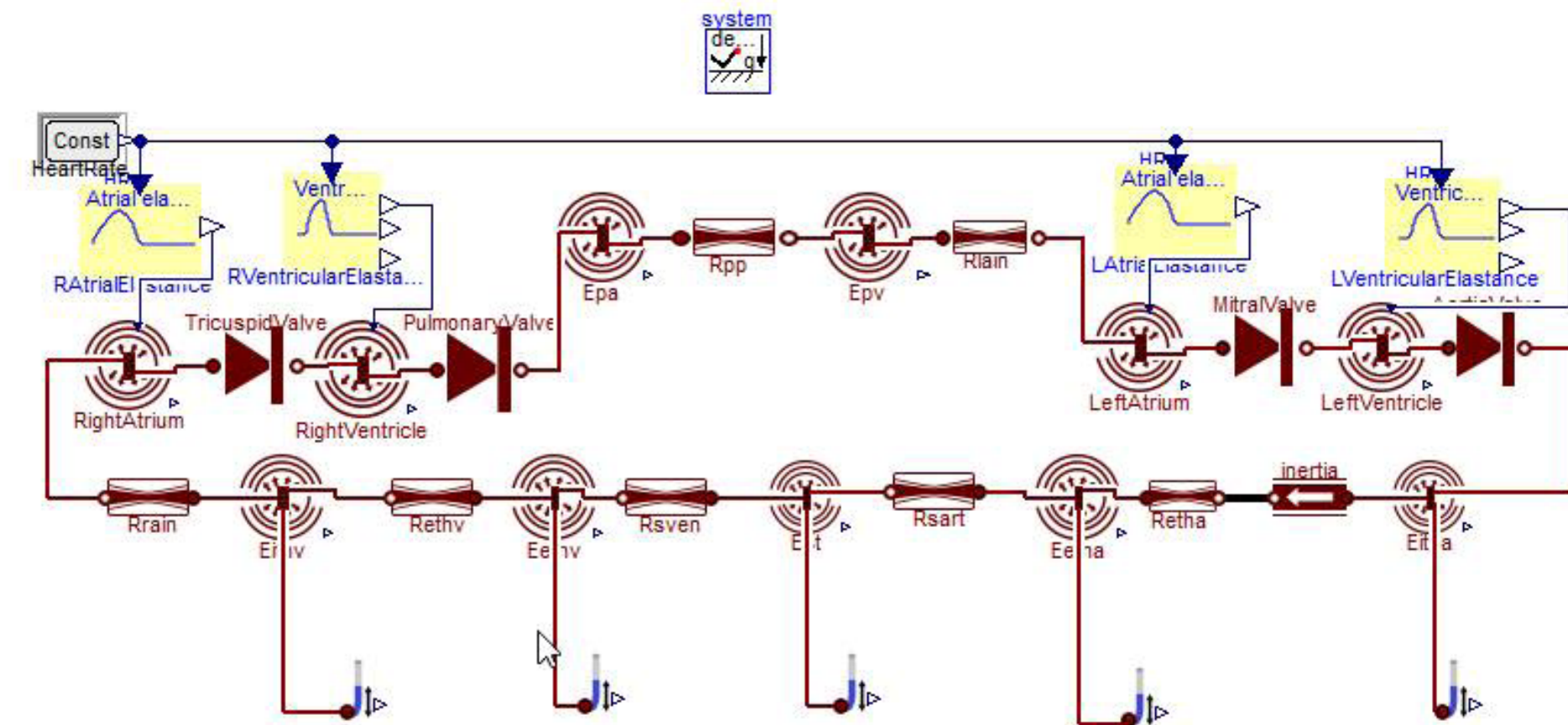
**BODYLIGHT**

# Problem

- complex problems in biology and medicine can be formally described as a set of mathematical equations- mathematical models

```
// Hepcidine-related stuff
der(hep) = hep_in - hep_out; // eq. 1
der(Bmp6) = Bmp6_in - Bmp6_out; // eq. 2
der(LPS) = -k_LPS_deg*LPS; // eq. 3
der(IL6mRNA) = IL6mRNA_in - IL6mRNA_out; // eq 4.
der(IL6) = IL6_in - IL6_out; // eq 5.

// Duodenum
Fe_duo = Fe_duo_2 + Fe_duo_3;
der(Fe_duo_2) = Fe_duo_in_food + Fe_duo_in_ser - Fe_duo_out_ser -
der(Fe_duo_3) = Fe_duo_to_ferritin - Fe_duo_from_ferritin;
der(Fpn_duo) = Fpn_duo_in - Fpn_duo_out; // eq 7.3
der(Fpn_duo_mRNA) = Fpn_duo_mRNA_in - Fpn_duo_mRNA_out; // eq 6.3
```

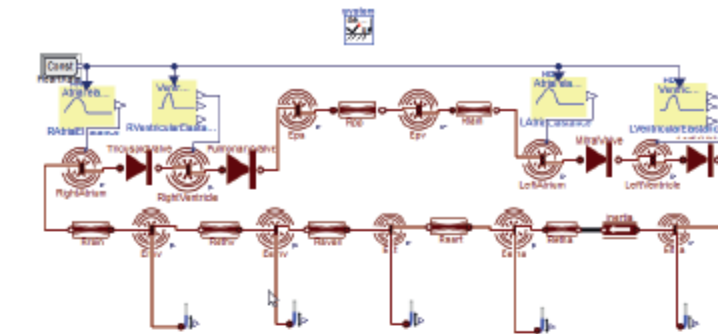


- Model simulators are hard to be implemented as computer software and visualize interactively
- Models of normal, pathological and clinical physiology are not yet widely used in education, clinical praxis, medical and biotechnology product design.

# Solution

- Bodylight toolchain – <https://bodylight.physiome.cz>
- Step 1: Author can compile models in modeling language Modelica into WebAssembly, which enables the models to be executed in standard web browsers (Bodylight.js-FMU-Compiler)
- Step 2: Author can write web simulator using HTML and using our ‘Bodylight.js-Components’ which are configurable standard web-components (HTML like tags) adding interactive elements, web components are interpreted by standard web browser
- Web simulator = HTML & webcomponents only, no Javascript programming

model as diagram



Source code of web simulator: (no code, only HTML and custom webcomponents)

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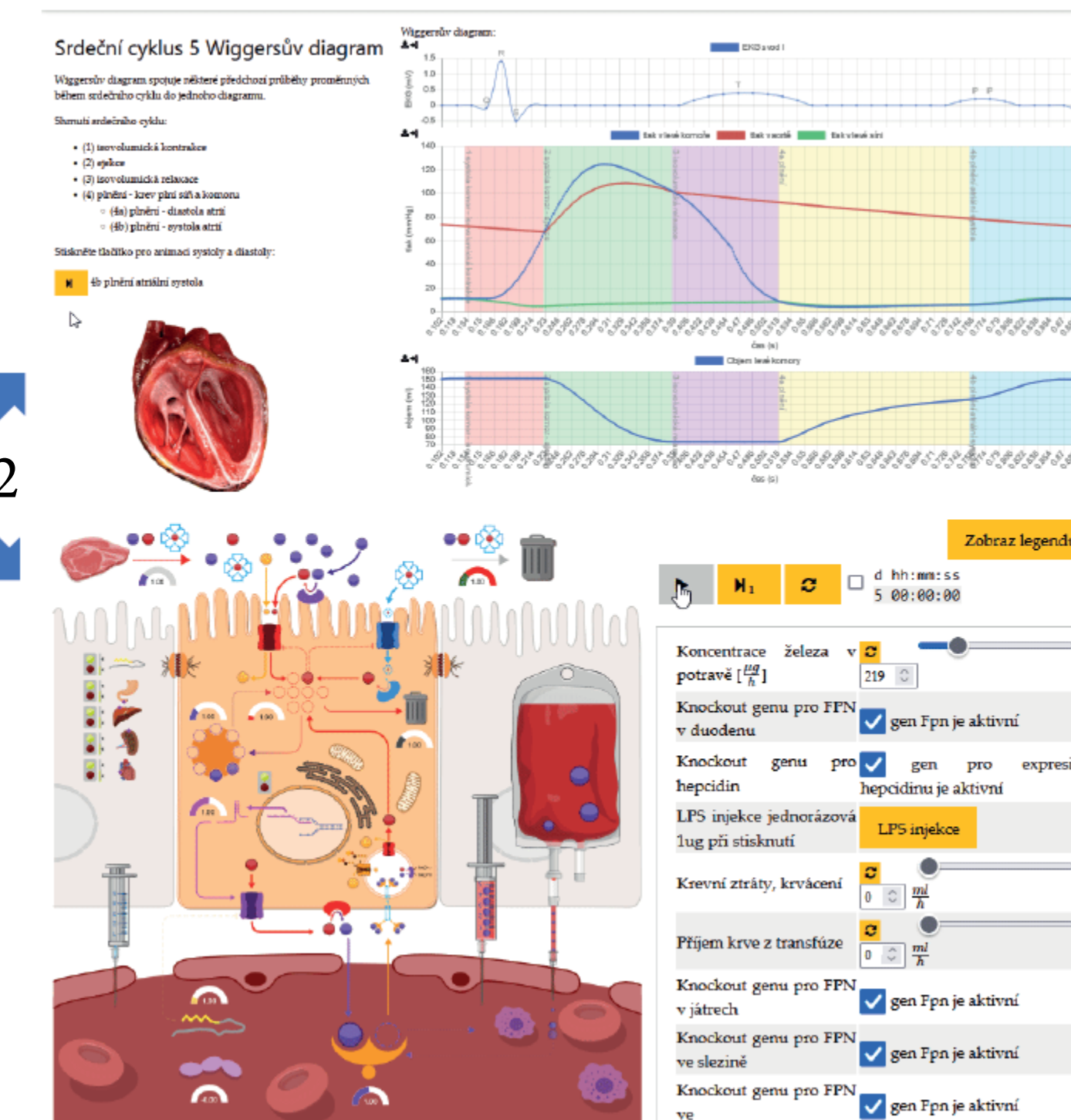
model as equations

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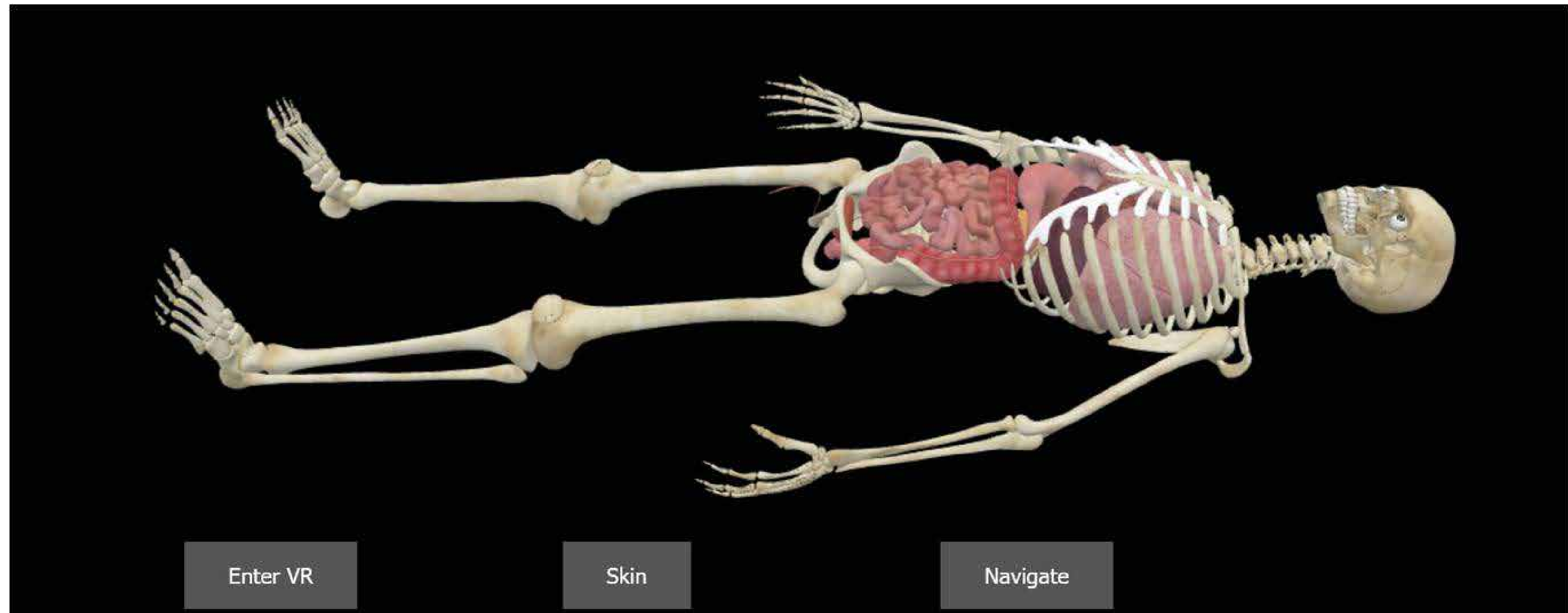
web animation with web simulator



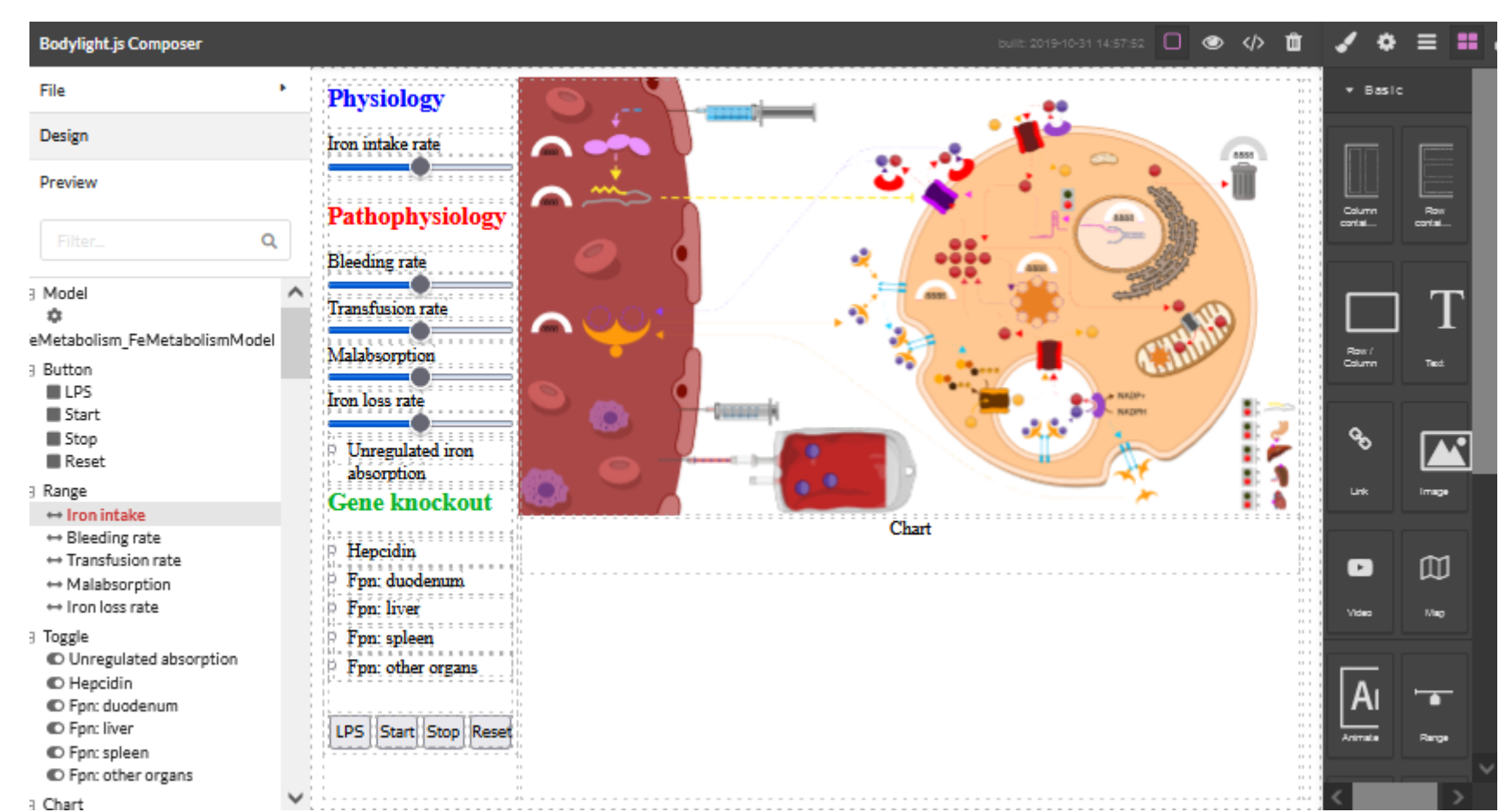


# Solution

- Web simulators can be executed in virtual or augmented reality
- demo: <https://bodylight.physiome.cz/VR/breathing/>



# Solution – no-code and low-code tools to create web simulator



**Bodylight-Composer**  
**no-code** tool to create basic  
web simulator

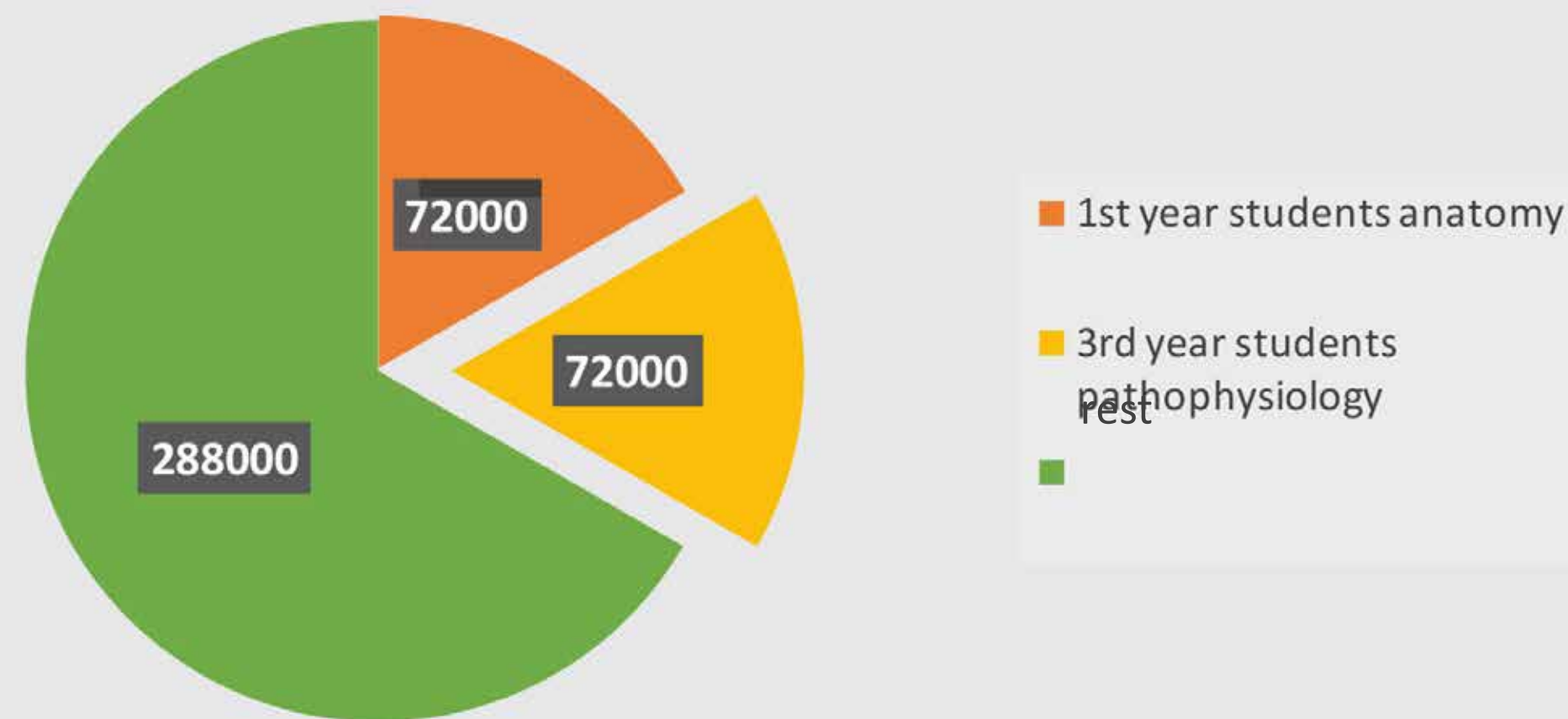


**Bodylight-Editor**  
**low-code** tool to create advanced  
web simulator

# Business plan A

- Interactive atlas of physiology, pathophysiology and clinical physiology
  - Problem – there are few interactive materials covering complex features of physiology and pathophysiology
  - Solution – online book with web simulators using Bodylight technology, we have domain experts to create the content
  - Potential market among students and clinical specialist

**Estimate of 432 000 students of medicine in EU28**



demo- interactive hemodynamics

<https://bodylight.physiome.cz/Bodylight-Scenarios/hemodynamics/>

demo – physiology of iron metabolism

<https://bodylight.physiome.cz/Bodylight-Scenarios/ironmetabolism/>

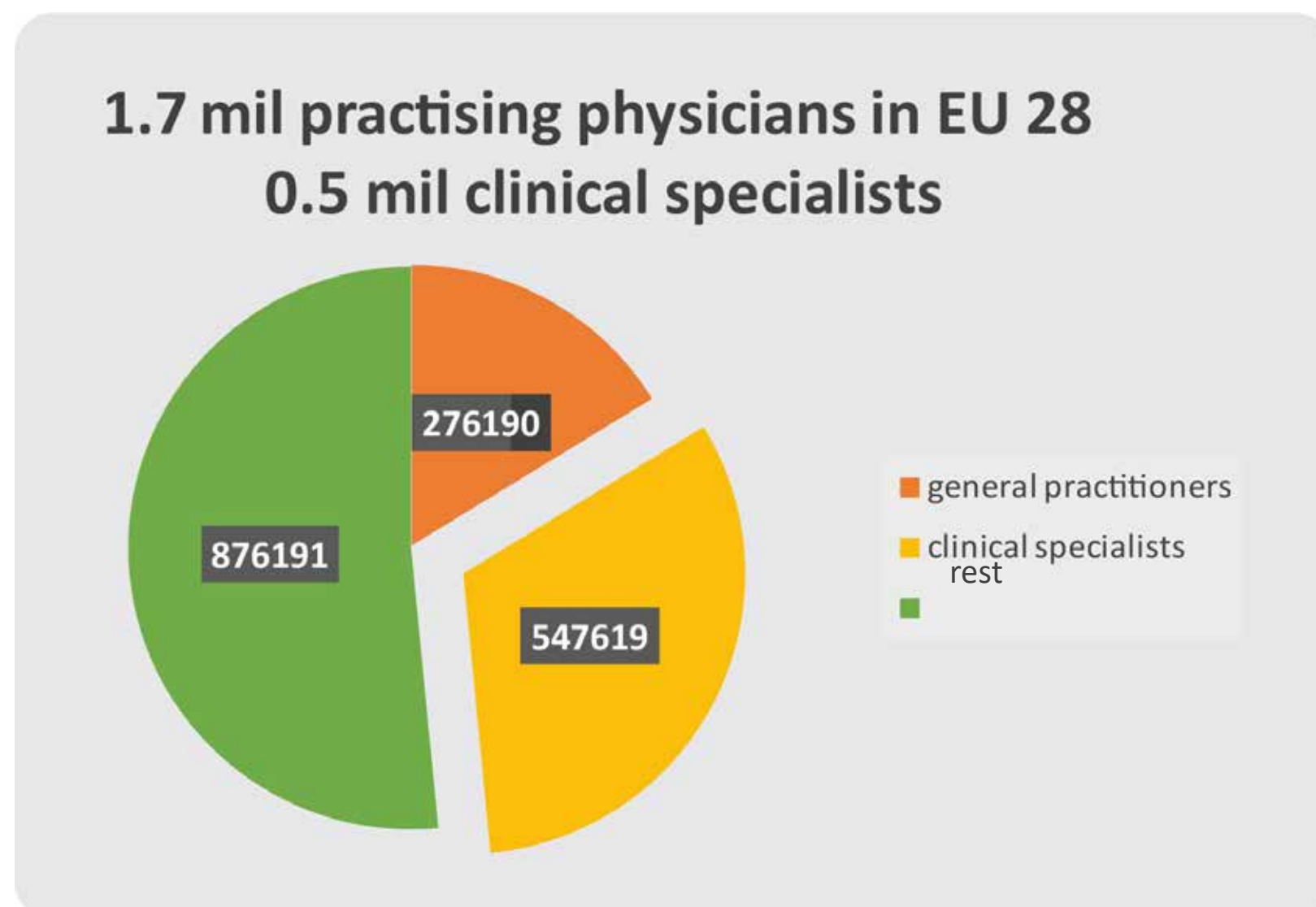
data, Eurostat 2018

[https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Healthcare\\_personnel\\_statistics\\_-\\_physicians#Healthcare\\_personnel](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Healthcare_personnel_statistics_-_physicians#Healthcare_personnel)



# Business plan B

- Create and use models to deliver web simulators for other (not only medical) domains
  - B2C or B2B
  - our tools and technology facilitates connecting different domain experts, software engineer, modeler, graphical designer to create interactive web simulator
  - sell access to advanced tools, customer can fine-tune simulators – Bodylight-Composer, Bodylight-Editor
  - Goal: Increase usage of simulators to provide precise pharmacotherapy
  - Goal: Decrease time of delivery of solution with web simulator
  - Model source code – usually open source, Model parameters – know-how of potential business partner



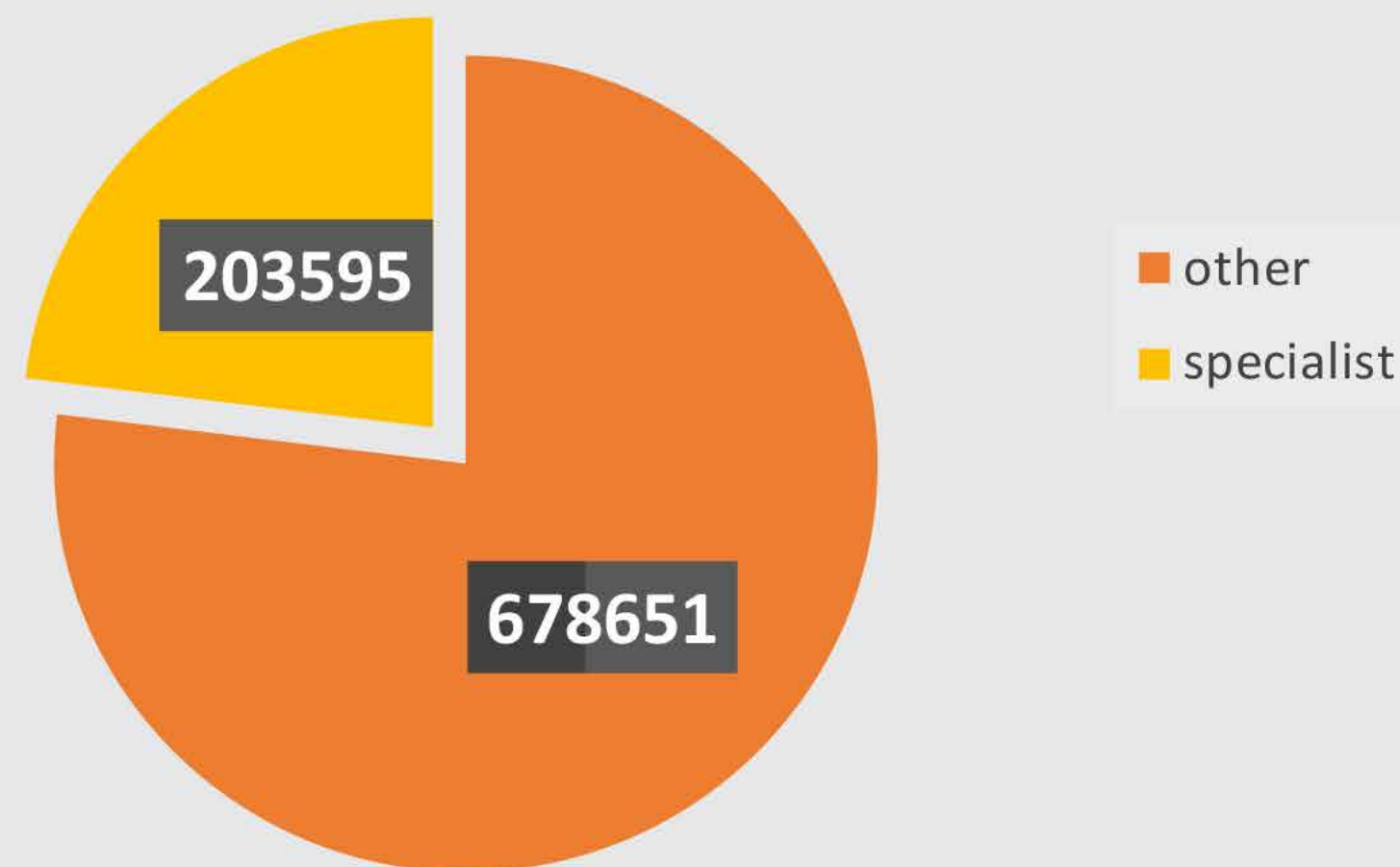
data, Eurostat 2018

[https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Healthcare\\_personnel\\_statistics\\_-\\_physicians#Healthcare\\_personnel](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Healthcare_personnel_statistics_-_physicians#Healthcare_personnel)

# Business plan C

- Use models and tools from plan A and B to deliver simulators in virtual/augmented reality
  - B2B, Simulating human body, medical devices, training physician and other personnel in hospitals
  - Market – specialists in hospitals needing occasionally training on new devices or therapy, vendors of medical devices

**MD, specialist in hospitals need occasionally training on new devices in EU28**



demo - breathing virtual body with basic anatomy:

<https://bodylight.physiome.cz/VR/breathing/>

data, Eurostat 2018

[https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Healthcare\\_personnel\\_statistics\\_-\\_physicians#Healthcare\\_personnel](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Healthcare_personnel_statistics_-_physicians#Healthcare_personnel)

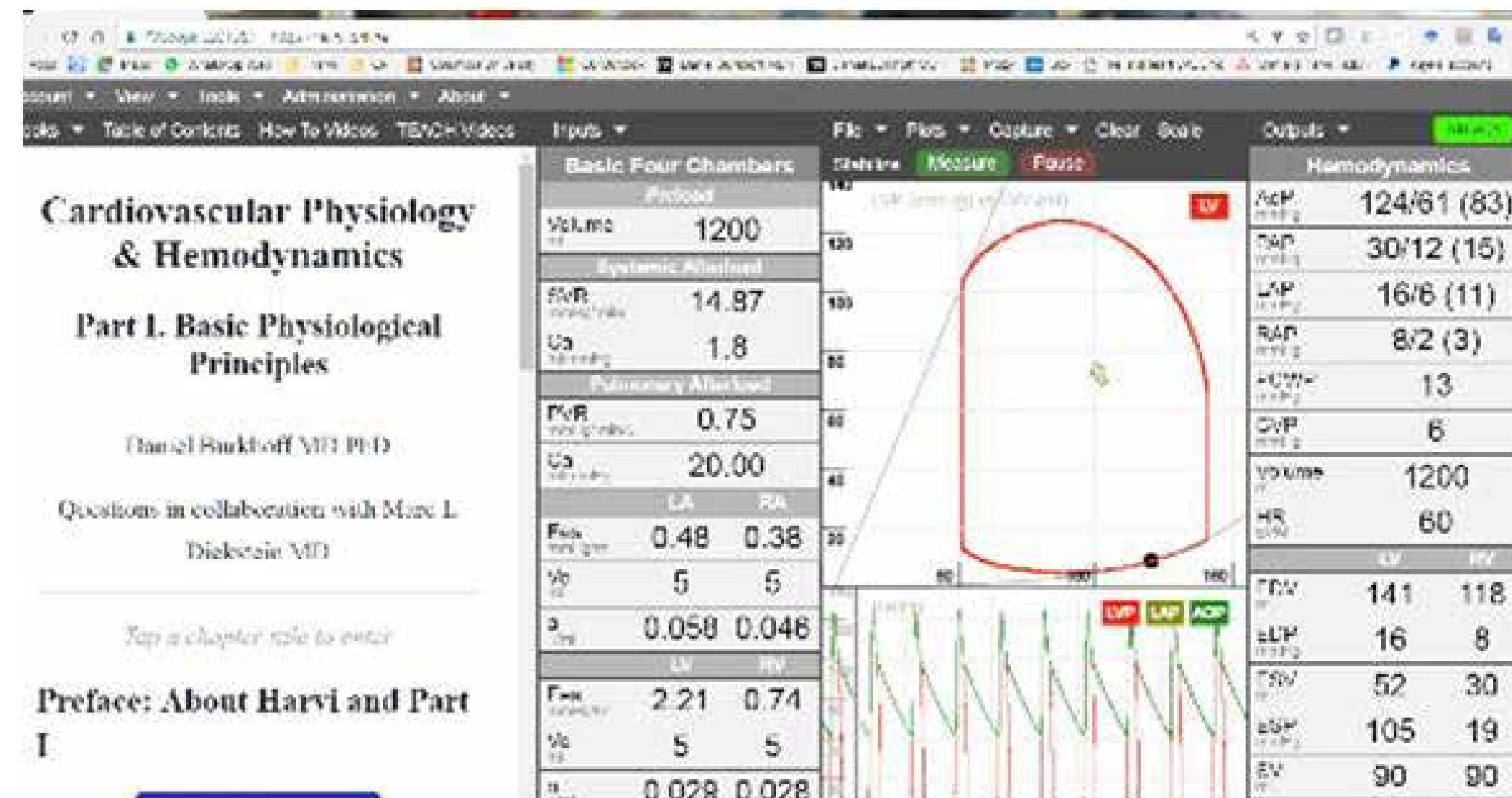


# Potential competitor

- Lot of free online videos – authors and users potential customers
  - Our advantage is that the web simulators are live –not prerecorded videos
  - we can input values into scenarios and get answer/solution in terms of physiological explanation
  - This gives feedback about understanding the concept
- Few interactive simulation based – harvi online – cloud based simulation of hemodynamics

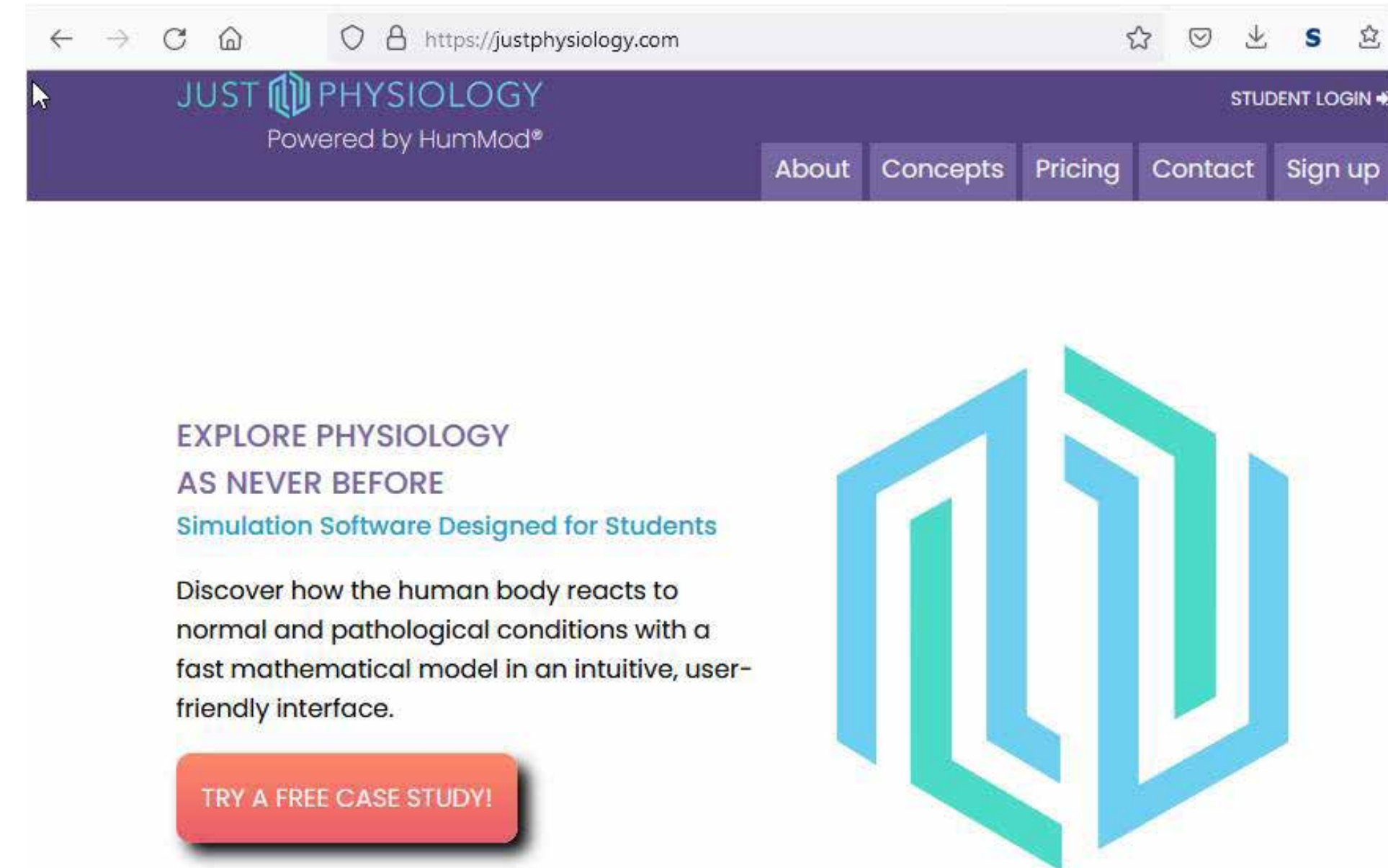
<https://harvi.online/site/welcome/>

- Our advantage – in-browser simulation
  - no need of cloud infrastructure
  - can be off-line,
  - Our model implementation is open source part of [www.physiolibrary.org](http://www.physiolibrary.org)



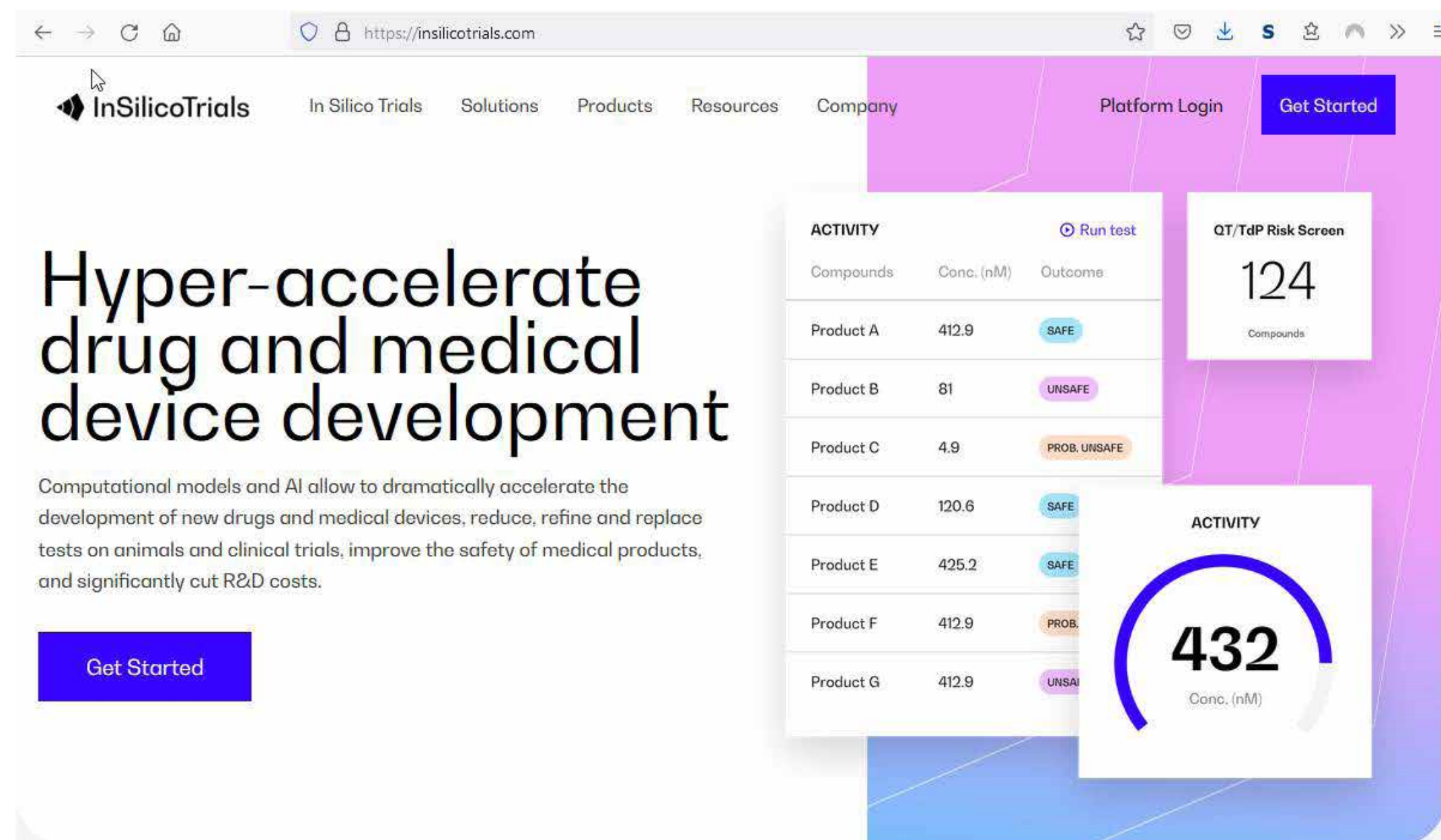
# Potential competitor

- JustPhysiology <https://justphysiology.com/>
  - Based on HumMod – most advanced and complex model of physiology
  - Lot of charts and educational material
  - Used in some US universities
  - Models source is closed – almost closed
- Our advantage
  - We reimplemented and enhanced HumMod in Modelica language as open source model, see [www.physiomodel.org](http://www.physiomodel.org)
  - We have advanced interactive graphics
  - We can be partners in EU or contractors for advanced visualisation



# Potential competitor

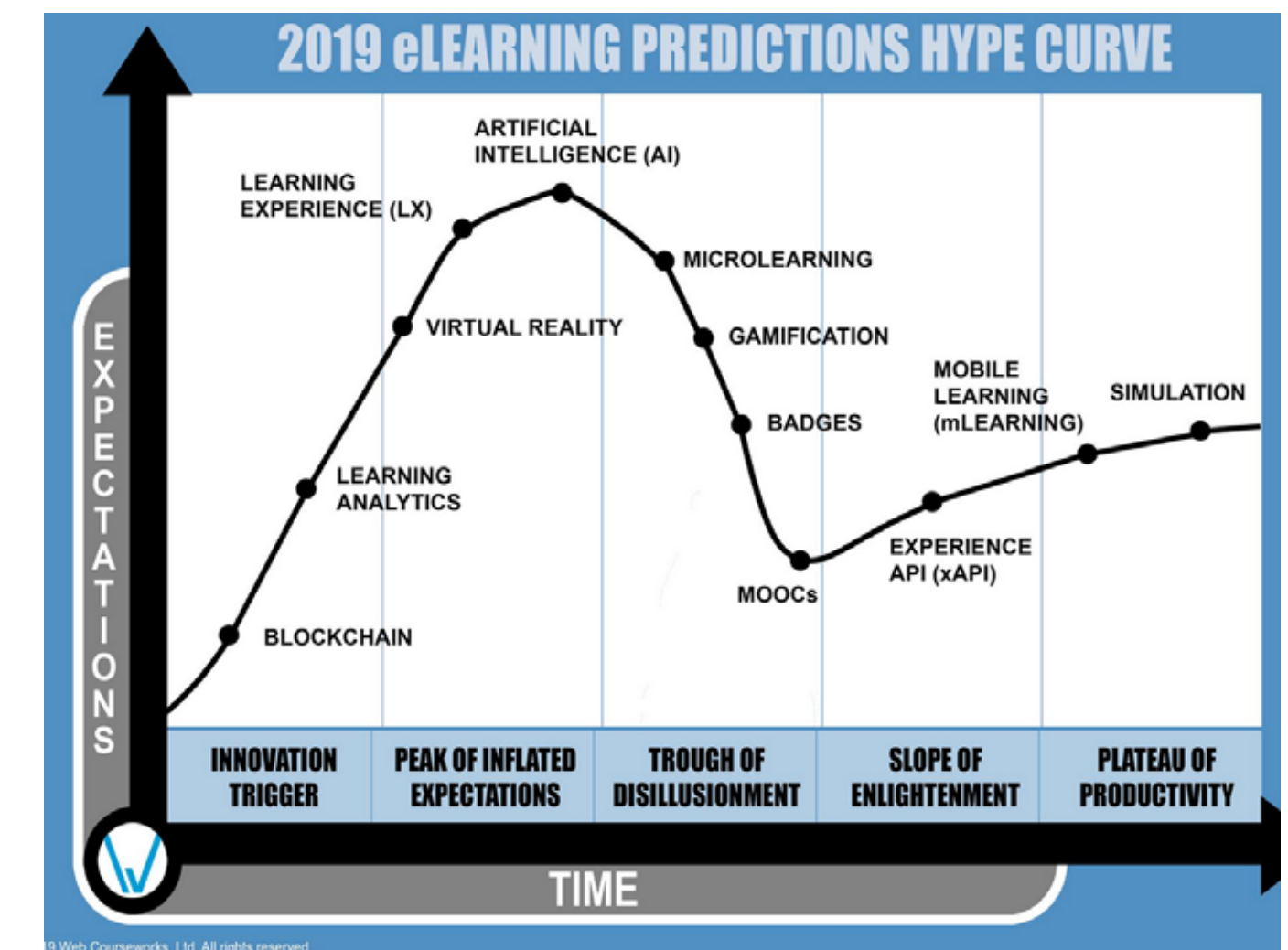
- InSilicoTrials – [www.insilicotrials.com](https://www.insilicotrials.com)
  - Evangelist in the use of simulation in the clinical-trial phase of testing drugs and medical products
  - They use finite-element method (3D model) simulation
  - We use mechanistic models (1D) and 3D approach is actively researched in the technology domain we use (partial differential equation in Modelica)
  - We can be contractors delivering in-browser simulators and advanced visualisation





# Technology innovation in e-learning and Life Science R&D

- WebCoursework's document 'Hype Cycle for eLearning 2019' before COVID-19 lists e-learning methodologies and technologies in different phases of hype cycle.
  - Our plan A focus on 'Simulation' which is already in plateau of productivity. 'virtual/augmented reality' was in rise, however in 2020 and further it is expected to go to disillusionment.
- Gartner's Research Document 'Hype Cycle for Life Science Research and Development, 2020'— lists different innovation technologies again in different phases of hype cycle. Our plan B and C focus on these:
  - On the rise
    - Digital Life Science Platform (DLSP)
    - Immersive AR/VR/MR experience in life science
  - At the Peak
    - Clinical Data Analytics Platforms
    - RWE in Clinical Research
  - Entering the plateau
    - Scientific Analytics Platforms



# Team



**Jiří Kofránek**

*Co-Founder & visionary*

MD, Ph.D., Assoc. prof in  
technical cybernetics



**Tomáš Kulhánek**

*Co-Founder & CTO*

MSc. in computer science,  
Ph.D. in biomedical informatics



**Jitka Feberová**

*Marketing and sales*

MD and Ph.D. in medicine  
and information sciences



**Arnošt Mládek**

MSc. In molecular physics,  
Ph.D. in biochemistry and  
neuroscience,  
MD candidate 2023



**Klára Ulčová**

Diplome specialist in 2D  
and interactive graphics



**Martin Brož**

Diplome specialist in 2D  
and 3D computer graphics

# History

- Multidisciplinary team members
  - We teach medicine at Charles University
  - We teach modeling and simulation at Czech Technical University
  - We teach interactive graphics at High School V. Hollara
  - Source of multidisciplinary students and ideas – Dipl.spec. in computer graphics, M.Sc., Ph.D. students in computer science, biomedical engineering and biomedicine
- Creative Connections s.r.o. founded in 1992
  - Formerly publishing company
  - From 2000 principal investigator or participant of research grants – with Charles University and other SME
  - Funding MSc. and Ph.D. students
  - From December 2021 changed incorporation documents , 3 founders, increased the base capital, focus on technology transfer to market
- Investment history
  - Founders already invested 160 000 EUR in the past 20 years
- Aim to create subsidiary company focusing on business only



# Selected scientific publication

- ŠILAR, Jan, David POLÁK, Arnošt MLÁDEK, Filip JEŽEK, Theodore W KURTZ, Stephen E DICARLO, Jan ŽIVNÝ a Jiri KOFRANEK. Development of In-Browser Simulators for Medical Education: Introduction of a Novel Software Toolchain. Journal of Medical Internet Research [online]. 2019, 21(7) [cit. 2019-11-25]. DOI: 10.2196/14160. ISSN 1438-8871. <https://www.jmir.org/2019/7/e14160>
- Kurtz, Theodore W; DiCarlo, Stephen E; Pravenec, Michal; Ježek, Filip; Šilar, Jan; Kofránek, Jiří; Curtis Morris Jr, R: [Testing Computer Models Predicting Human Responses to a High Salt Diet: Implications for Understanding Mechanisms of Salt Sensitive Hypertension](#). **Hypertension**, AHA/ASA Journals
- JEŽEK, Filip, Tomáš KULHÁNEK, Karel KALECKÝ a Jiří KOFRÁNEK. Lumped models of the cardiovascular system of various complexity, **Biocybernetics and Biomedical Engineering**, 37(4), str. 666-678, [online]. [cit. 2018-09-12]. DOI: 10.1016/j.bbe.2017.08.001. ISBN 0208-5216. <https://linkinghub.elsevier.com/retrieve/pii/S0208521617300268>
- Kulhánek T.,Kofránek J. and Mateják M. Modeling of short-term mechanism of arterial pressure control in the cardiovascular system: Object oriented and acausal approach. Computers in Biology and Medicine, Received 15 May 2014, Accepted 22 August 2014, Available online 1 September 2014. <http://dx.doi.org/10.1016/j.combiomed.2014.08.025>

# Investment round 1

- Seeking for 250 000- 400 000 EUR
- Hire 6 people to develop MVP for plan A
  - online atlas of physiology, pathophysiology and clinical physiology 30 chapters of selected areas of physiology and pathophysiology
- Hire 2 people to improve low-code, no-code tools for plan B and C
- Gain customers/users, create simulators in different applied physiology and seek business opportunities for plan B and C

<https://bodylight.physiome.cz>