Propojení výuky oborů Molekulární a buněčné biologie a Ochrany a tvorby životního prostředí OPVK (CZ.1.07/2.2.00/28.0032)

ENERGETICS AND THE EVOLUTION OF HUMAN BRAIN SIZE

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INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

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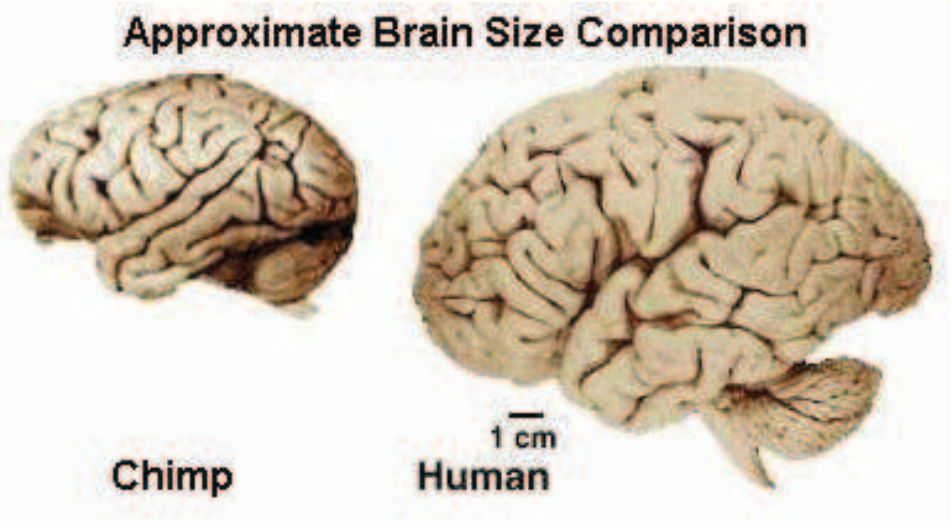
Brain

- Brain enlargement is one of the most obvious aspects of human evolutionary history
- Human brain – unusually large, 3x larger than that of the chimpanzee – requires much more energy (realtive whole-body energy consumption rates of individuals at rest are about equal in the two species)



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- Brain tissue accounts for 2% of adult body mass

- The energy consumed by the brain -> 20-25% of an adult‘s consumption (65% of a baby‘s)

Brains are energetically expensive

- Question of how humans manage to cover the energetic requirements of their much enlarged brains

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The expensive-tissue hypothesis

- Proposed by Aiello and Wheeler in 1995
- Trade-off between the size of the brain and that of digestive track in anthropoid primates
  - The cost of brain expansion in *Homo* were coverd by reduction in gut size (digestive tract is smaller than expected for a primate of our body size)
- Suggestion: early hominins evolved larger brains as a dietary shift towards more meet and cooked food
- Broad acceptance in palaeoanthropology and many others fields
- Weak empirical support
- It would gain plausibility as a general principle if it were confirmed on other mammals

Opposing view

- Offered by Navarrete *et al.*
- They tested it in a sample of 100 mammalian species by analysing brain size and organ mass data

  They found no negative correlations between the relative size of the brain and the digestive tract among mammals or within non-human primates

- These results refute the expensive-tissue hypothesis as a GENERAL principle to explain the interspecific variation of relative brain size in mammals
- the gut-brain trade-off should be replaced by a fat-brain trade-off

- Energy trade-offs with other tissues that are less expensive but very abundant may explain part of brain size variation
- For instance – adipose depots (not metabolically expensive but adipose tissue has a energetic cost)
- Fat stores -> enable to cope with periods with reduced food intake = physiological buffer against starvation
- Encephalization and fat storage are complementary strategies to buffer against starvation ????

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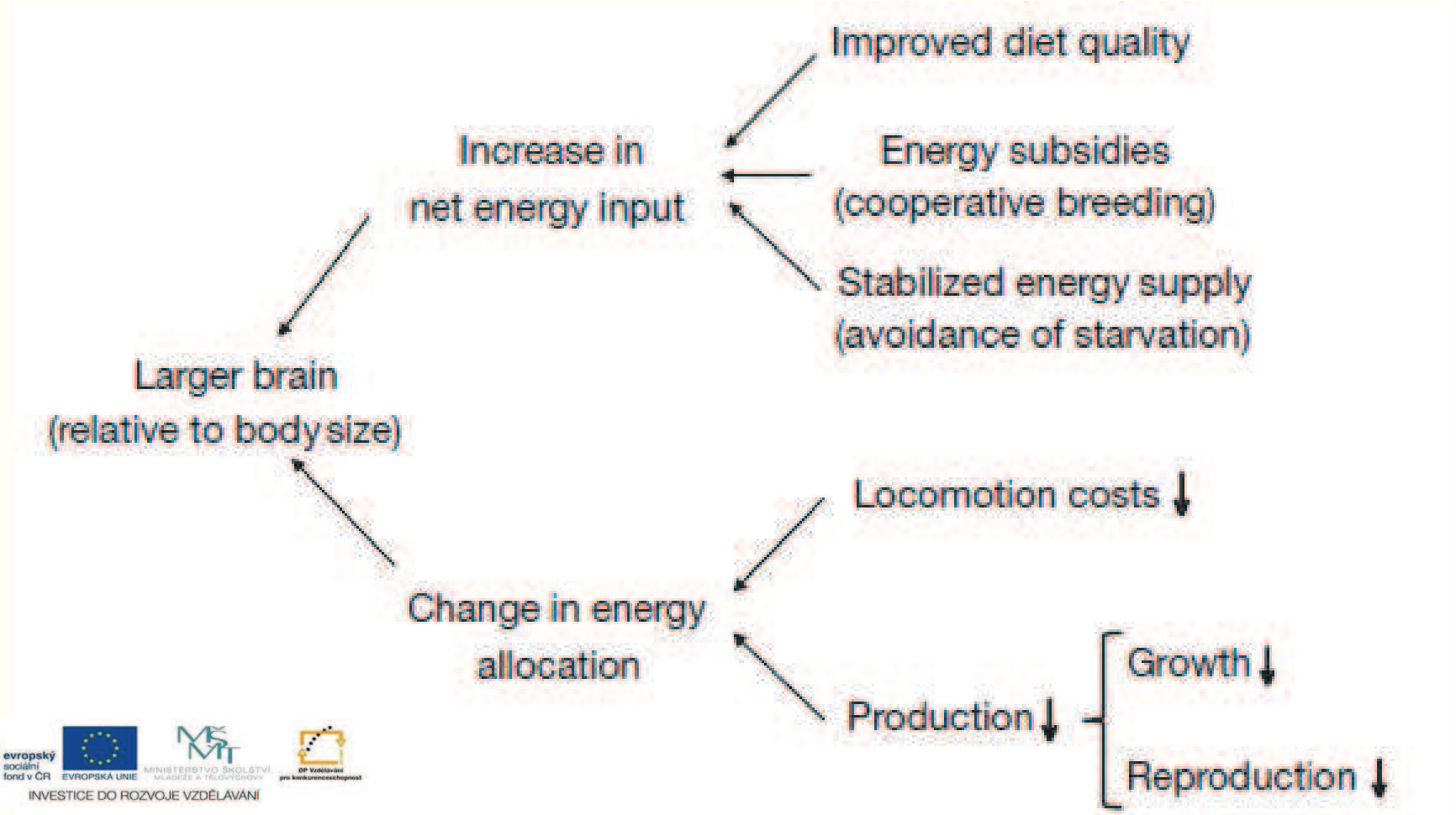
Pathways to brain enlargement …



Pathways to brain enlargement

Increase in net energy input

- Improved diet quality – consumption of meat and bone marrow + tool-assisted food processing including cooking
- Cooperative breeding

Increased energy allocation

- Trade-off between brain size and the cost of locomotion – bipedal locomotion x climbing and quadrupedal locomotion of nonhuman apes

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Summary

- Navarrete *et. al.* propose that human encephalization was made possible by a combination of stabilization of energy inputs and redirection of energy from locomotion, growth and reproduction.

Thank you for your attention

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CREATING A CURE-ALL

ANDREW R. SCOTT

Stem-cell transplantation can cure sickle-cell disease…

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Sickle-cell disease

- People with this disorder have atypical haemoglobin molecules called haemoglobin S
- Red blood cells have sickle, or crescent, shape.
- Characteristic symptoms include anemia, repeated infections and periodic episodes of pain.
- This disease is most common among people in the United States and Africa.

About Stephanie Alvarado-Ross

- 20-years-old patient with sickle-cell disease
- November 2013 – stems cells from her brother´s bone marrow were infused into her bloodstream
- → the donated cells repopulated her bone marrow and produced healthy blood cells
- → Stephanie is now free of the disease

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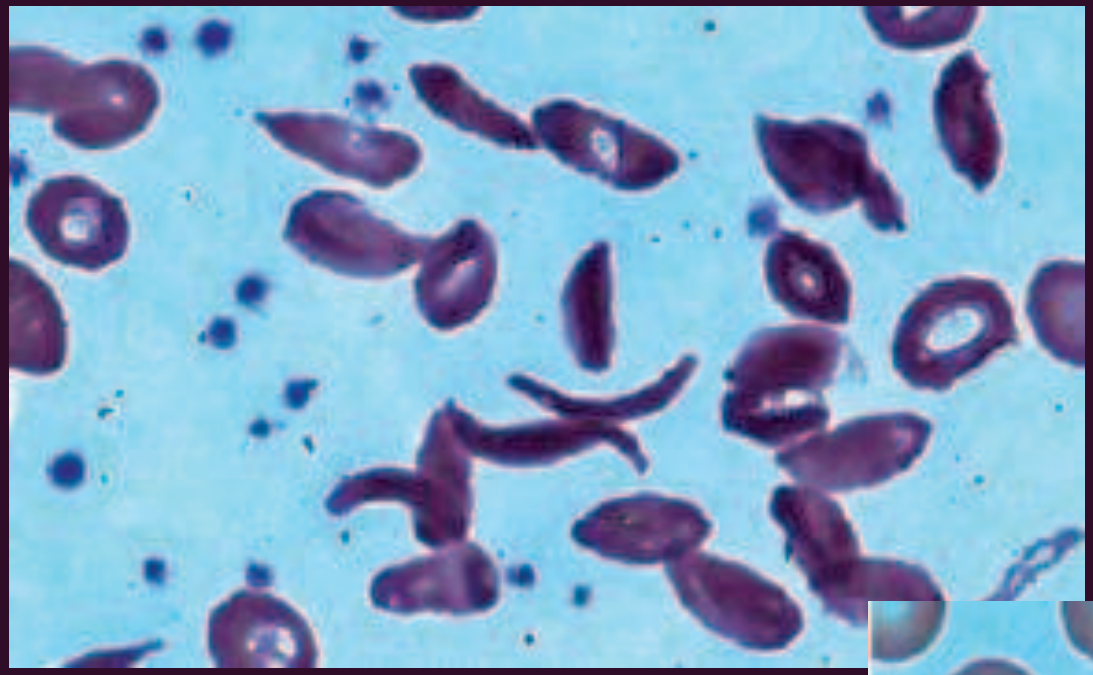

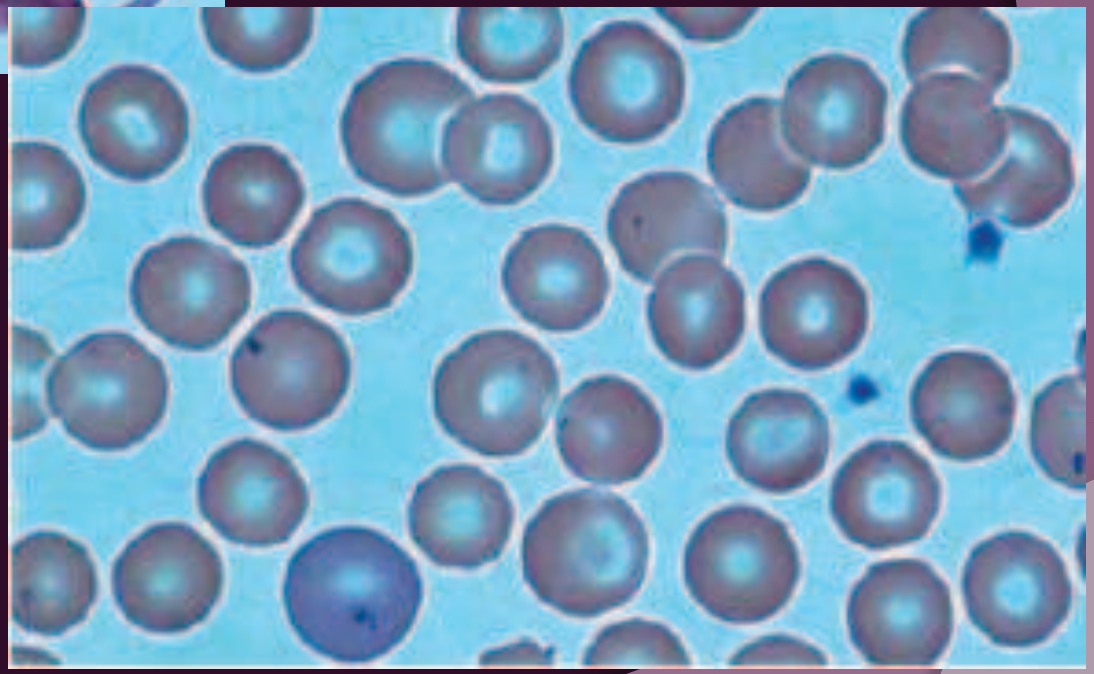

Blood from a patient with sickle-cell disease before (top) and after (bottom) a stem-cell transplant.

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Stem-cell transplantation programme

- Team lead by Leslie Lehmann
- Stem-cell transplant therapy has cured about 600 people worldwide
- In this therapy patient´s diseased bone marrow is killed off before being re-established with stem cells from a healthy donor´s bone marrow
- BUT – this procedure is not available to everyone !!

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Conditions

- It is generally offered only to children and adolescents, because the disease causes organ damage
- Another important requirement is having a fully immunologically matched sibling donor – someone with identical human leukocyte antigens (HLAs)
  - BUT – fewer than 10 % of people with sickle-cell disease have such a donor available

Problems

- Destroying the patient´s bone marrow and immune system with chemotherapy and radiation.
  - If the donor cells fail → patient´s outlook is bleak
- Other potencial problems – graft-versus-host disease, infections

- There´s 90 % cure rate but a 5 % mortality rate.

Recent research

- The procedure is more inclusive a safer.
- Broadening the age range of patients and increasing the pool of potencial donors.

- They found out that in small proportion of cases, donor cells were found living alongside native cells.
- → Having as few as 11 % of the donor cells in this “mixed chimaera“ is enough to overcome the disease.

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Recent research

- John Tisdale´s team from Maryland – they using lower dose of radiation, immunosuppression with the drug rapamycin and a novel monoclonal antibody called alemtuzumab.
- This antibody triggers the destruction of specific white blood cells in both recipient and donor.

Recent research

- They using this procedure in patients between 16 and 65 years of age.
- → Of the 30 subjects, 26 experienced successful transplant.
- → They removing one of the biggest limiting factors- a patient´s age

- They wanted to expanding the pool of donors to half-matched donors.

Recent research

- Robert Brodsky and his colleagues – They using half-matched transplant in adults.
- His procedure doesn´t include antibody treatment. They use cyclophosphamide – chemotherapeutic agent.
- His procudure was at first only a 75 % success rate but it was outweighed by a tenfold increase in the donor pool.

Recent research

- The more gentle procedure using post-transplant cyclophosphamide is spreading across The United States and overseas.
- They need to educating the wider medical community that transplantation is becoming an option for adults.

Recent research

- The most dramatic extension of the age range for stem-cell transplants – the affected cells are replaced before birth in the womb.
- A team led by Alan Flake has successfully treated sickle-cell disease *in utero* in mice and dogs.
- They collect stem cells from the mother and injected them into the bloodstream of the fetus.

Recent research

- The trials showed that the recipients were completely tolerant of the donor cells.
- They promoted the treatments in developed nations where few countries have the resources to undertake these types of transplant.
- Bringing the emerging treatments to every part of the world will be an economic and political challenge.

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