UNIVERSITÄT LEIPZIG

Faculty of Sport Science – Institute of Movement & Training Science in Sports

European Athletics
High Performance Conference 2019

Science in Sport
- Metabolism and Physiology -©

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Why this topic ???

- From the past coaching & training is very much influenced by aspects of "teacher training";
- So called "training theory" is mainly influenced by the "action theory" ("Trainingslehre") and has its roots in the "Russian" school (1960);
- At that time the correct and multiple "exercising" of movements in training was in the main focus;
- Scientific based aspects were introduced in sport & training science quite late (after 1960);
- There is still an existing conflict between the traditional points of view and the actual aspects of knowledge;
- These aspects (and some others) lead to partly unlucky and wrong consequences for the training process!

Conditions in practice

BUT:
No / few information about

- adaptation mechanisms as a biological background of performance,
- reasons & explanations for the long term & age related aspects of performance,
- metabolic aspects & background of training load,
- physiological aspects of training & training methods,
- valid & reliable tests, testing & training monitoring,
- … etc.

Disposition / content of the presentation:

1. Introduction - the classical aspect of adaptation
2. The protein cycle as a base of active muscle cell adaptation / metabolism
   a) fundamental aspects
   b) anabolic state
   c) catabolic state
   d) the "performance gap" between young talented & senior athletes
   e) adaptation vs. ability oriented training
   f) do we have any markers to detect the (optimal / right) stage of adaptation over the time?
3. Consequences & necessities for practice and science in sport / summary

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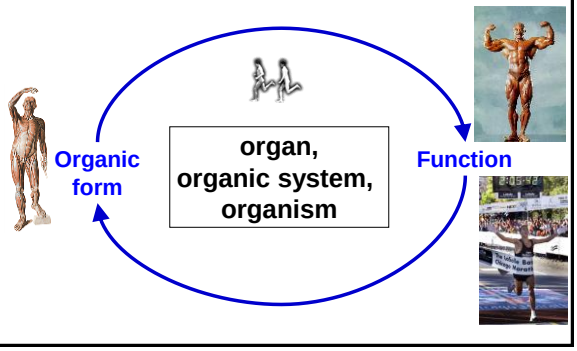
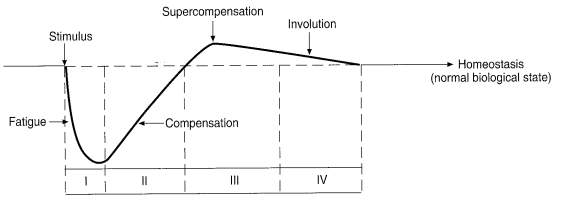
What affects the (sport specific / physical) performance ?



The model of "super compensation" according to Jakowlew and Harre is really nothing more then a "time curve" of a system with a "false overshoot" at the beginning and a "bad dumped response".



What type of system is "behind" the super compensation curve ?
This question remained unanswered since 40 years.

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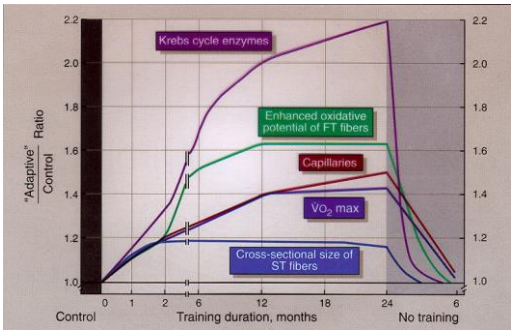
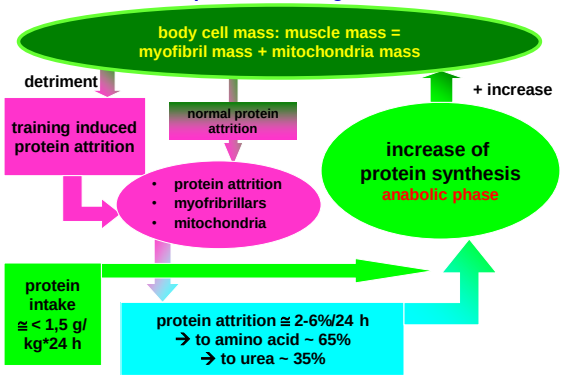
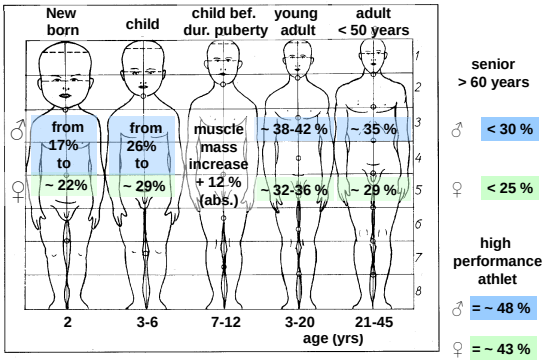


Behaviour of different biological parameters of a group of medium trained persons during a two year period (SALTIN, 1976)

Protein cycle of active muscle cell mass; positive training load



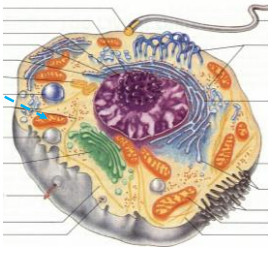
Body proposition/ muscle mass in life span



Mitochondria - Powerhouse of the cell

Mitochondria:

- Site of aerobic respiration
- Amount (+ 500%)
- Size (+ 50-70%)
- Surface (nearly triple)
- Location (more close to working muscle fibers)



Marieb 1992

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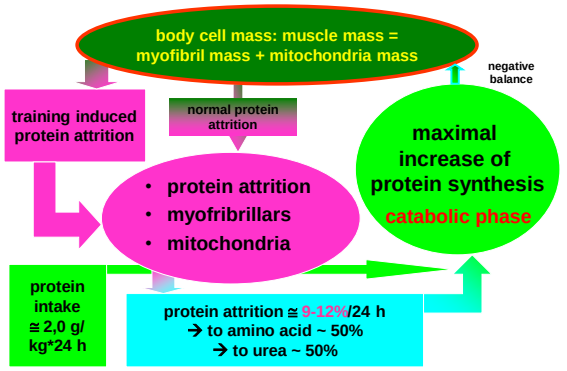
Protein cycle of active muscle cell mass; „Overload“/„Overtraining“/negative effect of training



The protein cycle as the base of active adaptation according to functional load:

- Every cell maintains its structure and therefore its protein content (cell mass) through a balance between protein synthesis and protein degradation.
- According to YOUNG (1980), FEHLIG et al. (1971) and others the average protein turnover of active tissues - like muscle cells - is about 3% / 24h up to 6% / 24h.
- That means that 97% of the existing proteins are replaced within about 90 to 30 days.

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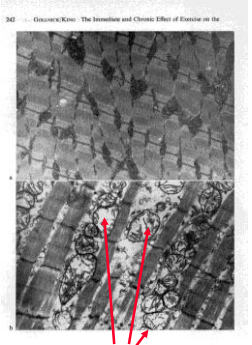
Dynamic of muscle cell adaptation

change of

Development & Training of the so called „high performance level“:

- As lower the training state, as more positive the adaptation effect; the „load tolerance“ is absolute low but relative great.
- As better the training state, as lower the effect of further adaptation; the „load tolerance“ is absolute better, but relative quite limited.
- If a high performance exists there are hardly no further adaptations because of biological limitations; the „load tolerance“ is absolute already (very) high developed but relative is the system quite unstable.
- Total wrong: „always more – always better“.

time



Structural turnover of mitochondria as function of excessive load

Mitochondria under average normal functional load of about 5% to 7% of VO_2max have a half-life time of about 24 days.(~ 4% turnover/24 h)

Mitochondria from brown adipose tissue, which have an average functional activity of ≥ 40% of VO_2max have a half-life time of about 11 days (~ 9% turnover/24h).

It can be estimated that during a marathon race of 2:20h with an average O_2 uptake of about 88% of VO_2max about ≥ 5% of the existing mitochondria is damaged and wasted (Costill) .

Conclusion: After maximal excessive exertion the structural recovery takes a relative long time of several weeks!

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Consequences for the practice?

Training should NOT be event specific !

-

Training should be ADAPTATION specific !!!

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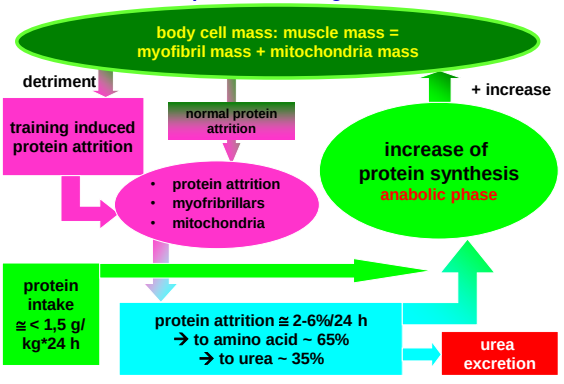

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Consequences / questions for practice and science in high performance sport

- **What** is the background of high performance in endurance sports? → definition of energetic / technical load profiles!
- **What** is z.B. „specific training" oder „staying power ability" under the aspects of adaptation & performance physiology? → problem of terminology vs. physiology!
- **What** are the individual facts what make athletes „fast" from point of physiology? → p.e. muscle fibre structure, adaptational aspects etc.
- **What** are the energetic / metabolic / adaptional processes which are "behind" the system? → problem with many consequences for the practical application in practice of training!
- **What** are necessary, valid & reliable diagnostic tools for diagnosis & testing the „competiive performance" by the point of physiology?
- **etc.** ...