Muscle oxygenation studies in athletes

Chris Cooper

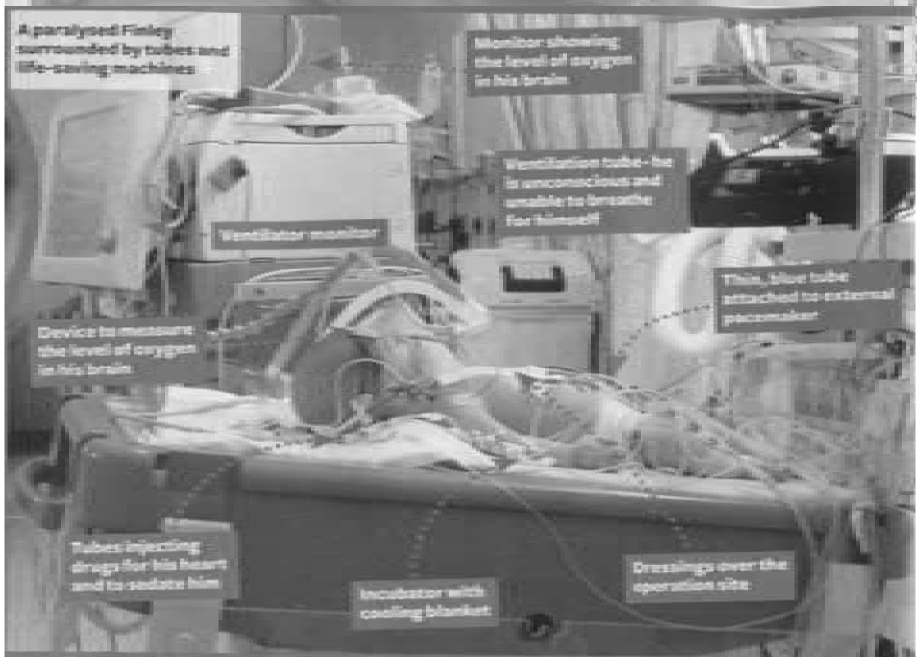
Slide courtesy of ILIAS TACHTSIDIS

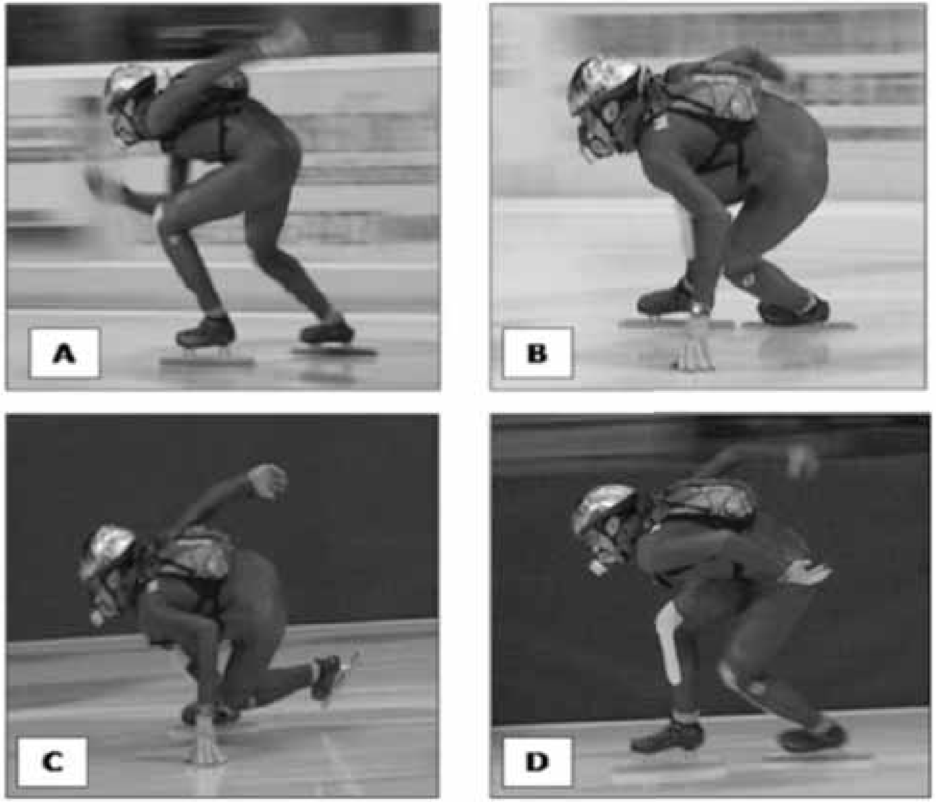
Near-Infrared Spectroscopy : an Established Clinical Monitoring Tool for the Brain?


www.metro.co.uk Thursday, November 29, 2007

A new heart at five weeks

Miracle: Sarah and John with baby Andrew

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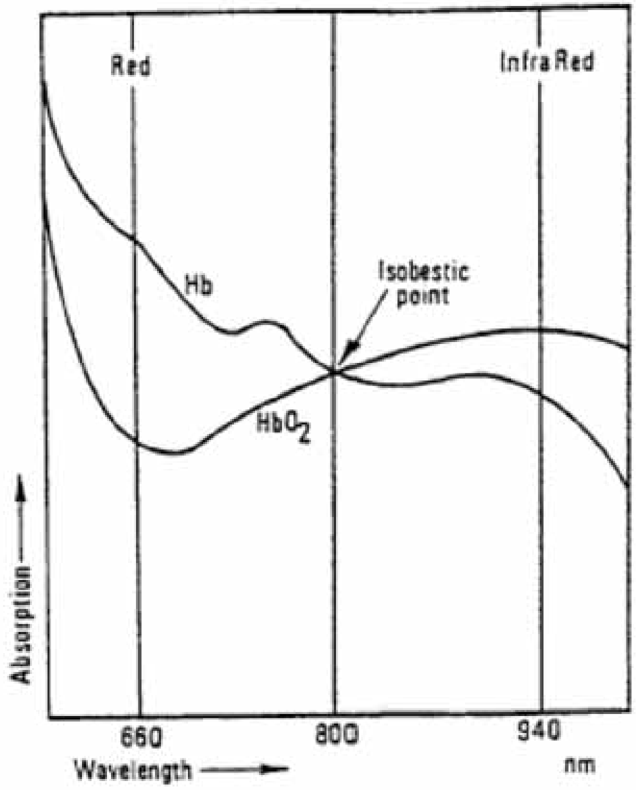
Outline of talk

1 Introduction to tissue optics

2 Use of near infrared spectroscopy (NIRS) to measure oxygenation in the muscle in vivo

3 Two examples from sports physiology

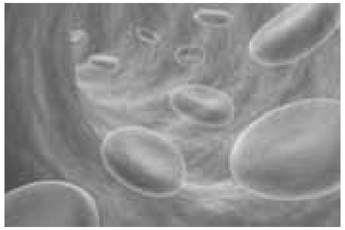


Near infrared spectroscopy

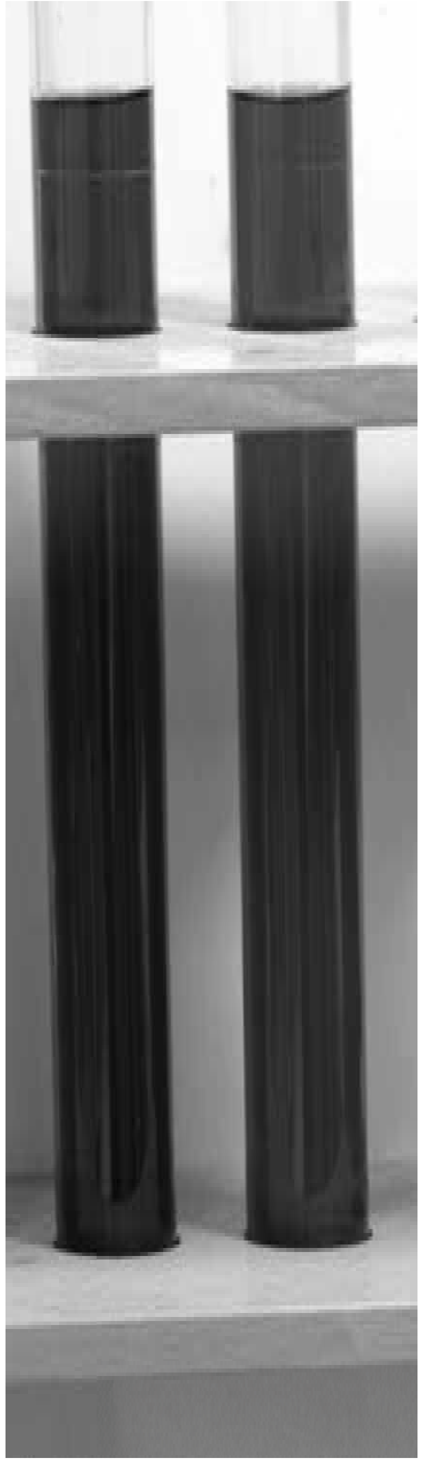
Arterial Hb saturation

$$\frac{[HbO_2]}{[Hb] + [HbO_2]} \times 100$$

Tells you how well lungs oxygenate blood

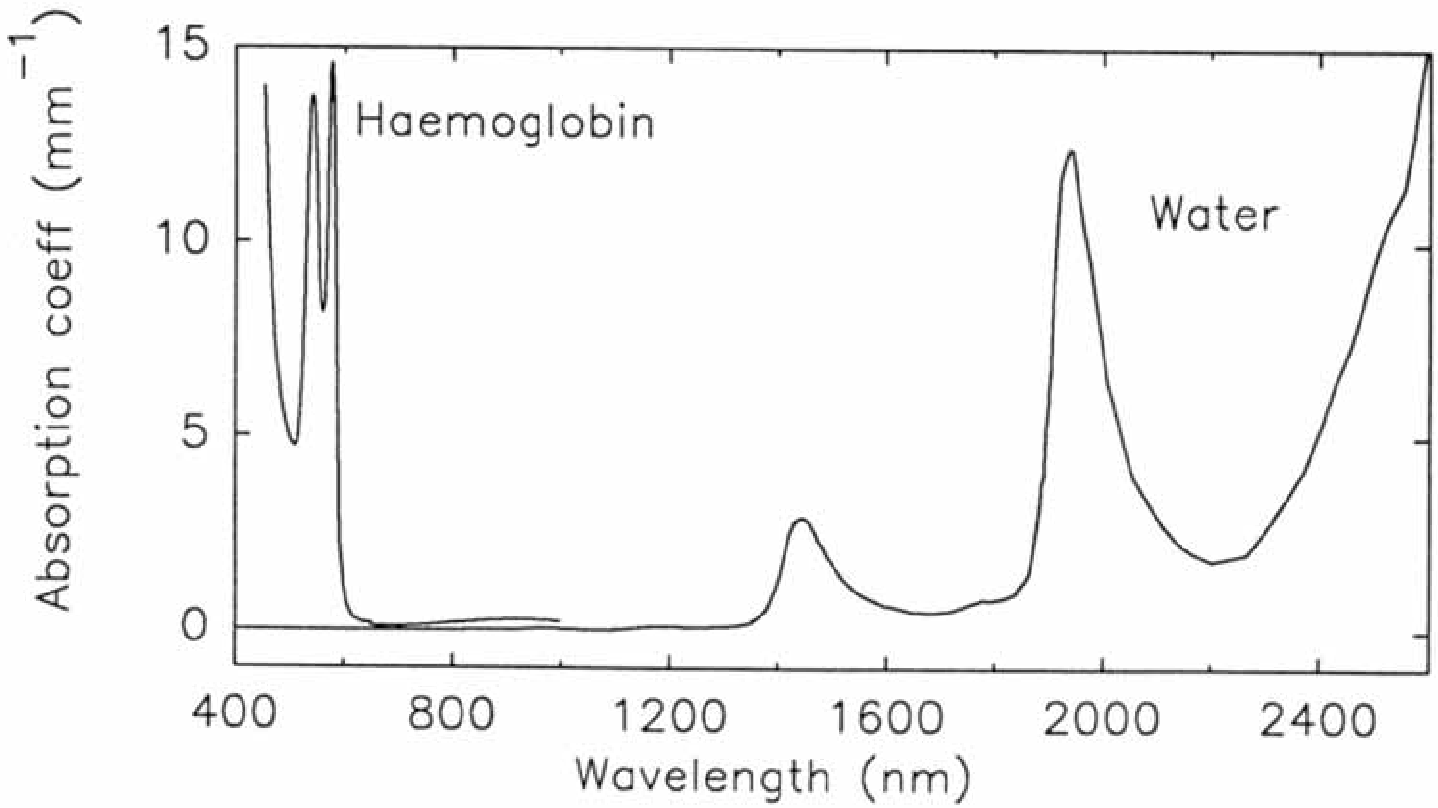


Haemoglobin (blood)

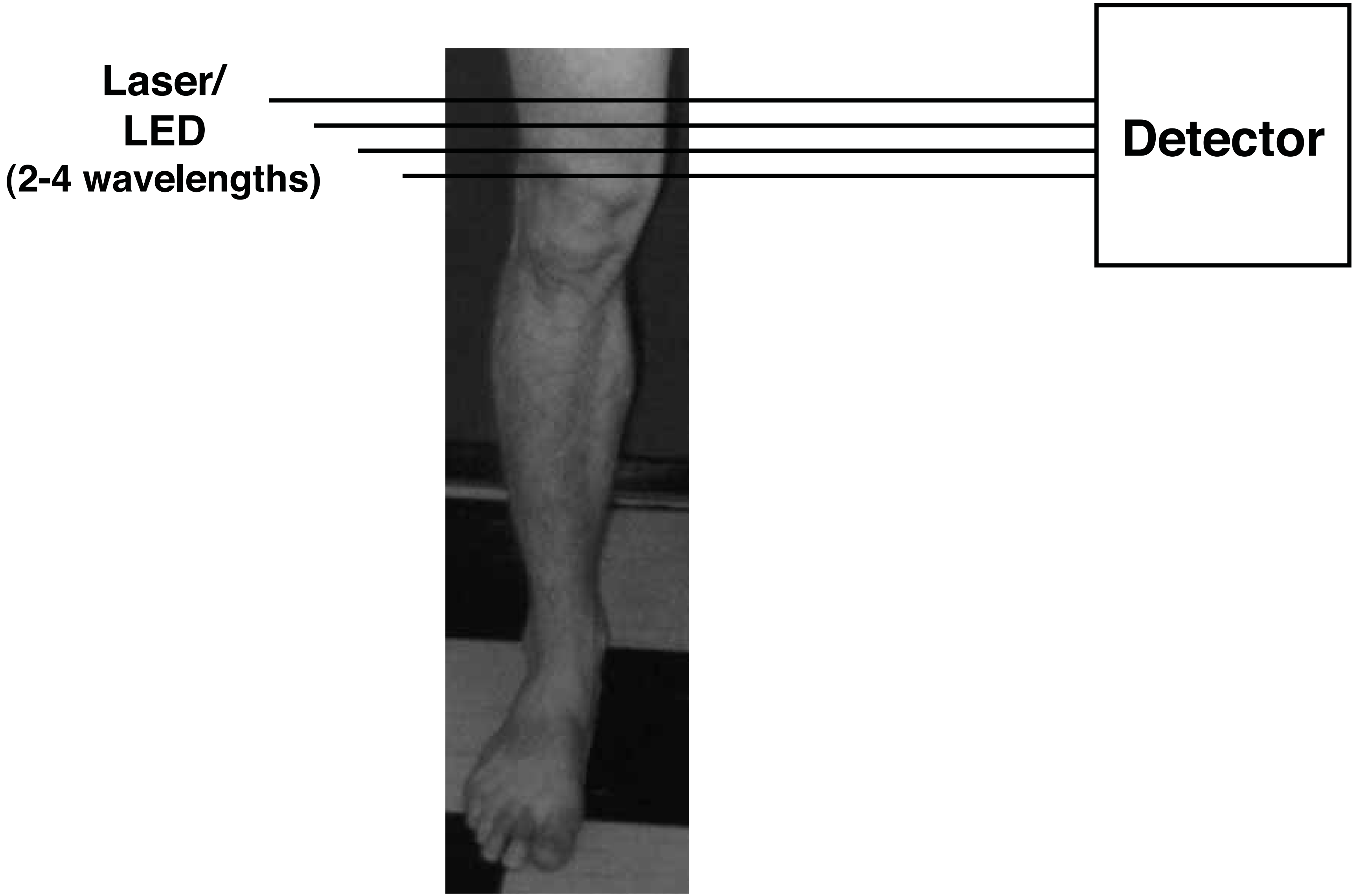


$$Hb + O_2 = HbO_2$$

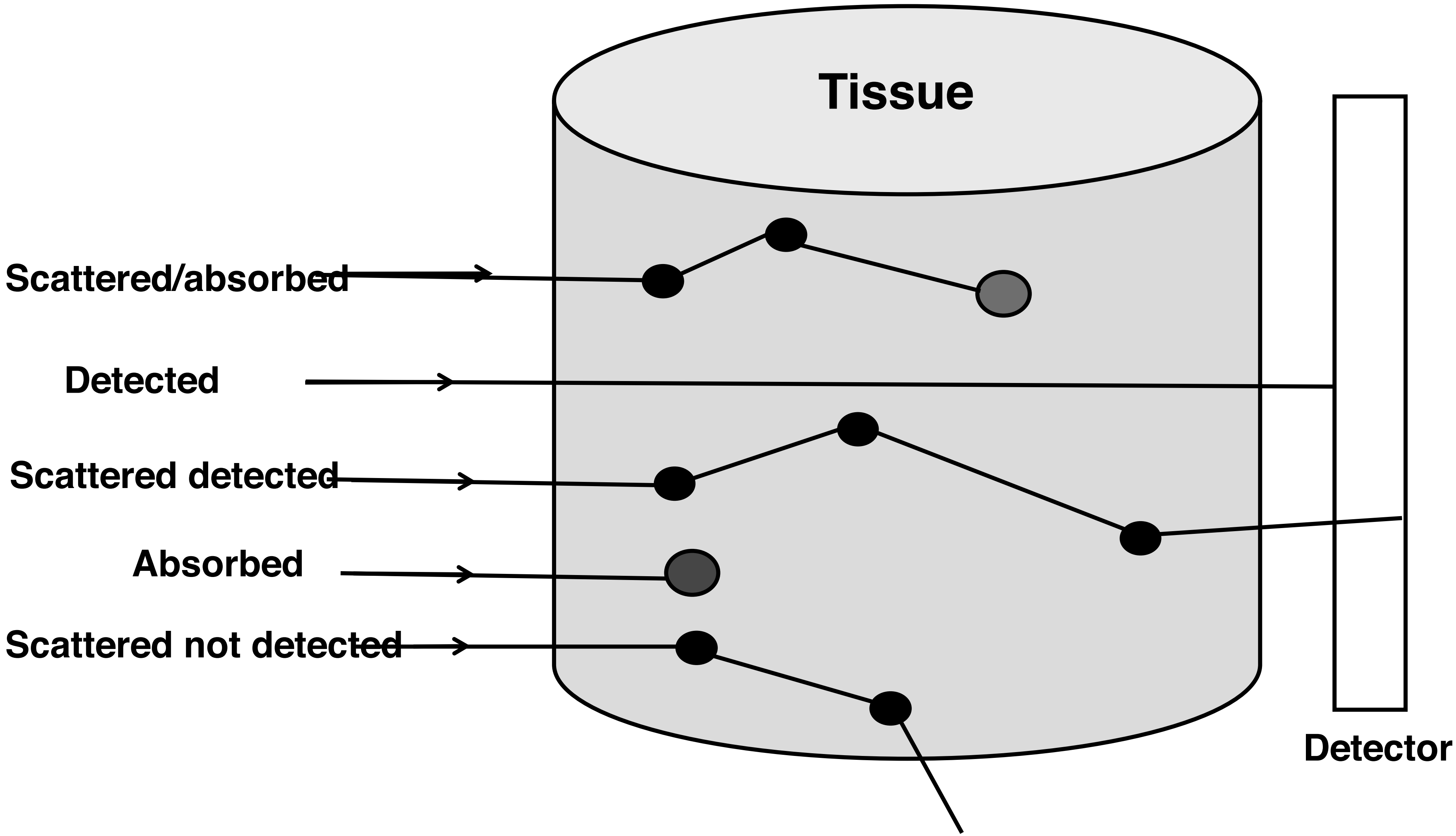
Basis of NIRS - light gets into tissue



Basic optical set up to detect multiple wavelengths of light simultaneously



What does NIRS measure?



Simple "continuous wave NIRS"

- Difference spectroscopy (tissue baseline)
- Assume scattering does not change
- Measure optical pathlength (cm)
- Beer-Lambert Law $\Delta A = \varepsilon.\Delta c.l.$

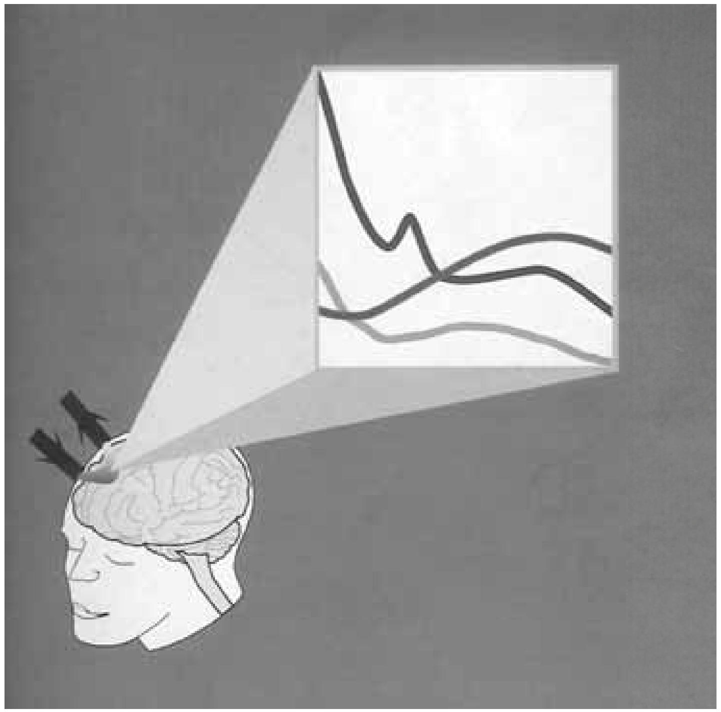
Measure (in ms time scale):

Δ HHb μM

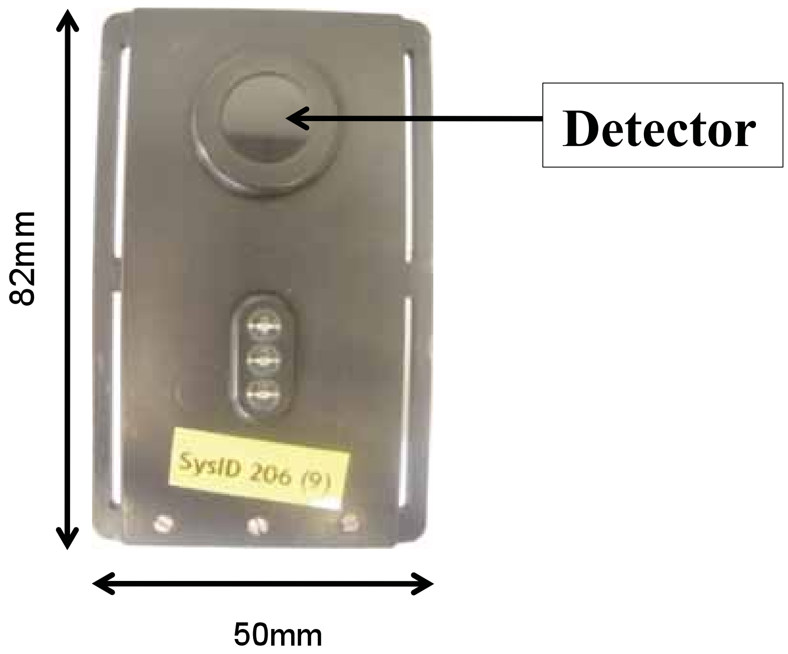
Δ HbO_2 μM

Δ total Hb ($HHb + HbO_2$) μM

Δ oxygenation (HbO_2 - HHb) μM



(myoglobin is elephant in the room)



Spatially resolved spectroscopy

Absolute Hemo(myo)globin % Saturation in tissue:

$$\frac{HbO_2}{Hb + HbO_2} \times 100$$

Where does the light go? Muscle

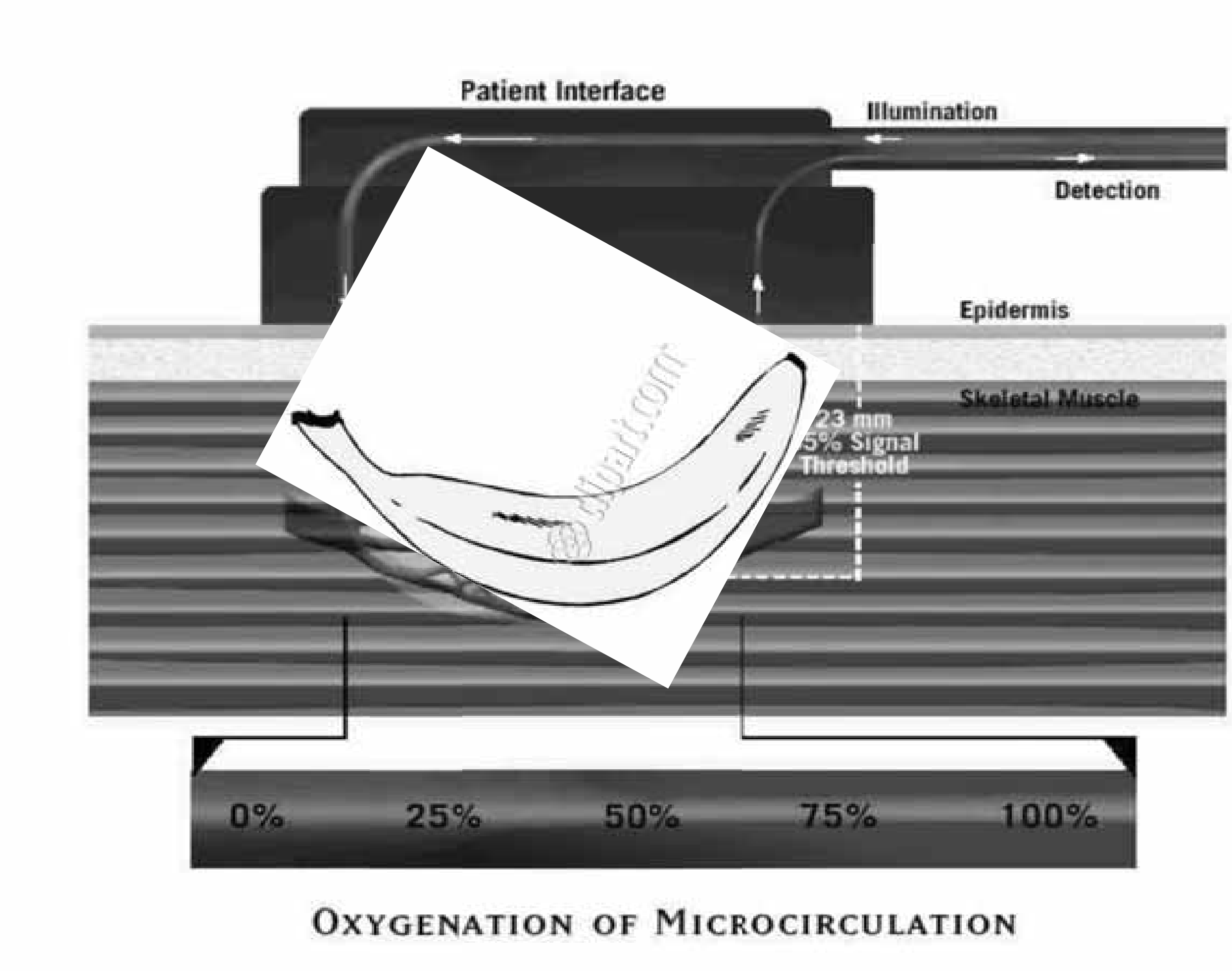
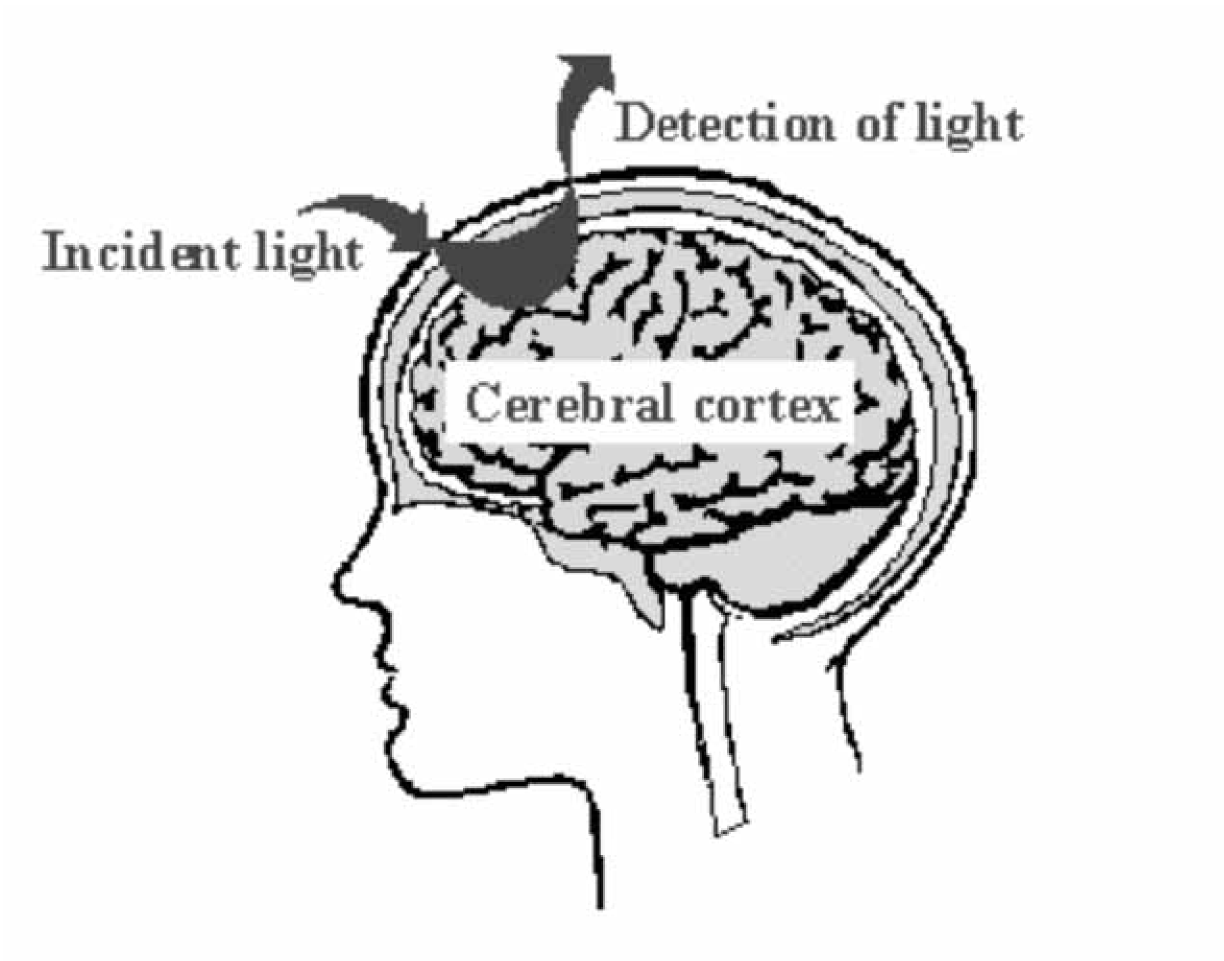
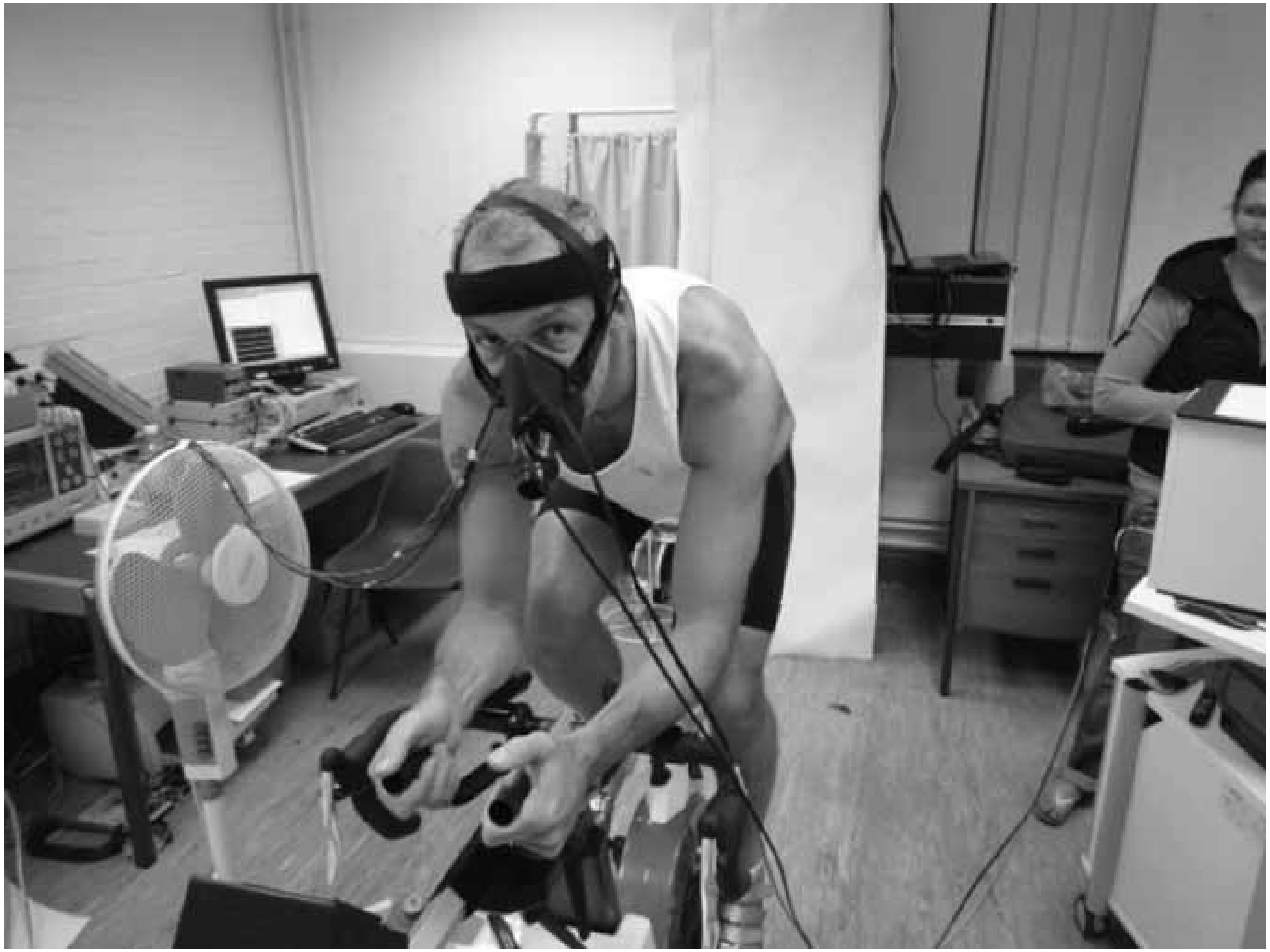


Image courtesy of Hutchinson Technology Inc.

Where does the light go? Brain



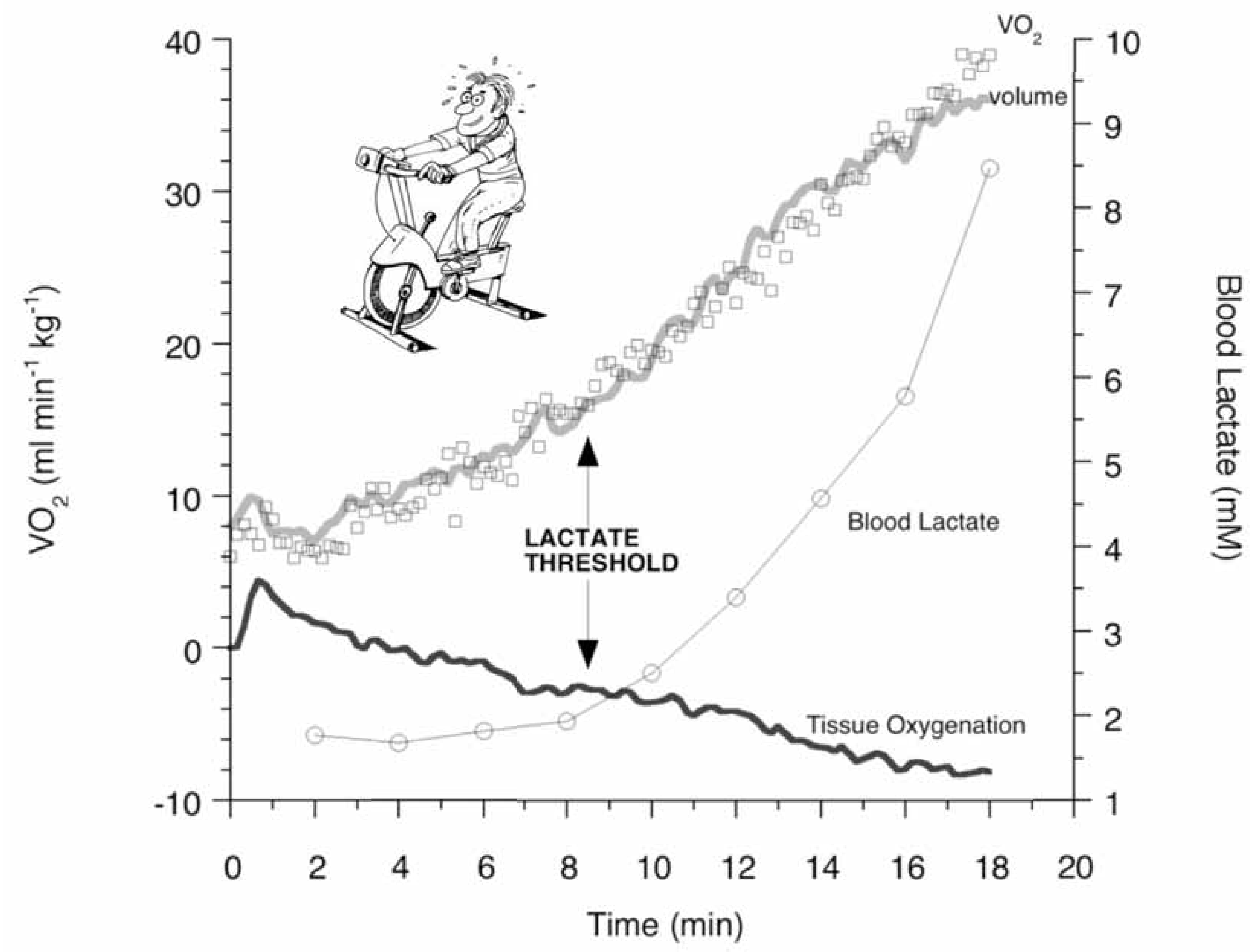
Measuring brain fatigue with NIRS in exhaustive exercise

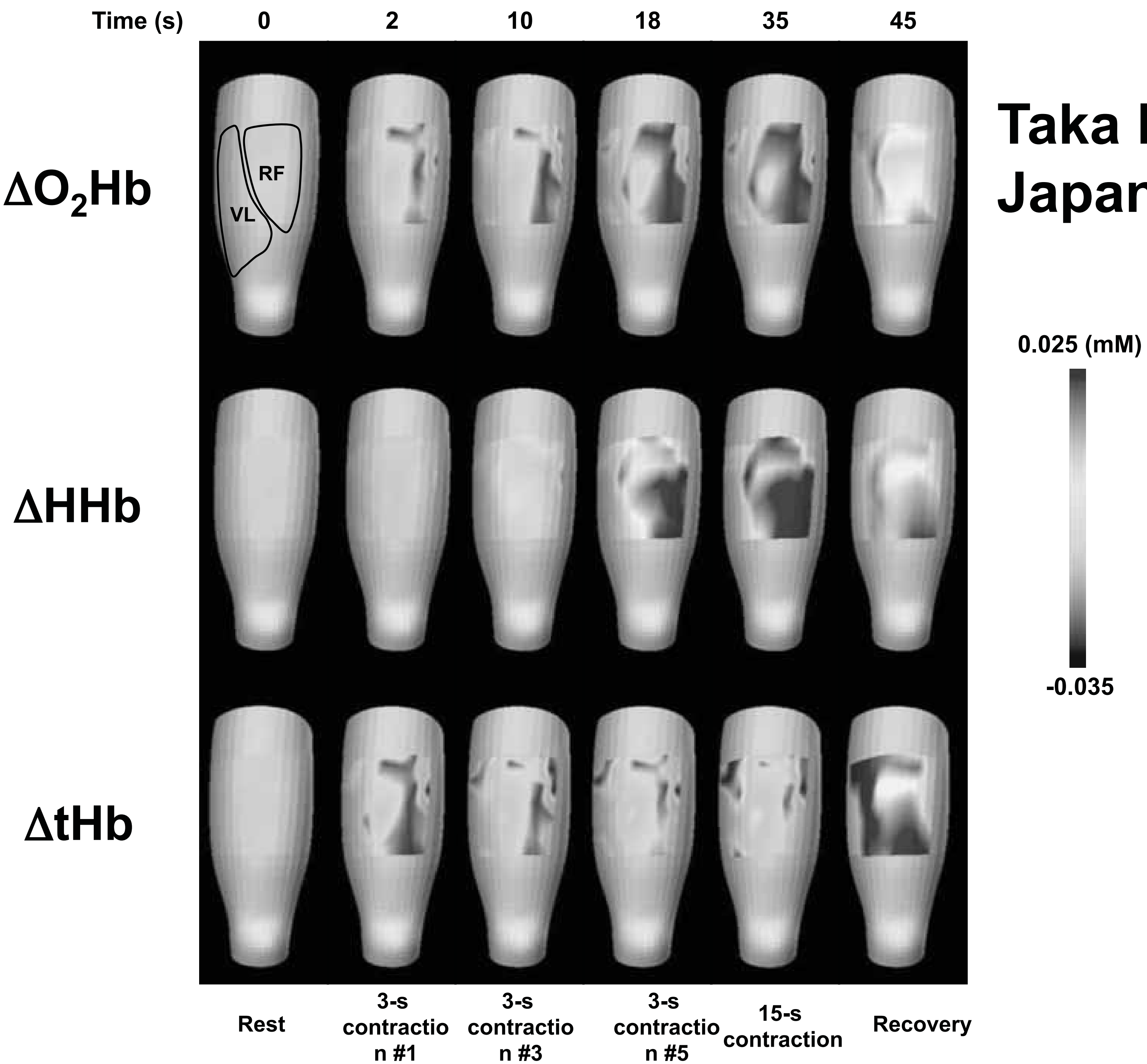


Dave Parry **Dominick Micklewright**

What happens to the muscle when it is activated?

Muscle activation deoxygenates tissue





Taka Hamaoka
Japan

University of Essex

UCL

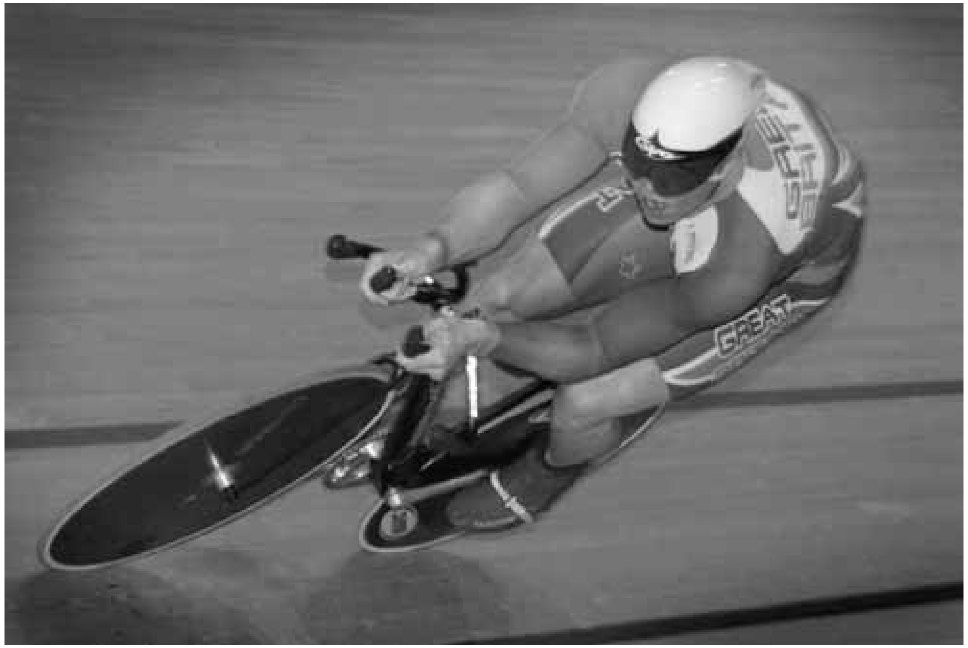
Effect of warm-up on muscle oxygenation and metabolism in supramaximal cycling

Anna Wittekind, Chris Cooper, Caroline Angus,
Clare Elwell*, Terence Leung*, Ralph Beneke

uk sport

EPSRC

Engineering and Physical Sciences Research Council



Conclusions

- Higher intensity warm-up
  - which raised BLC_{pre}
  - faster oxygen utilisation
- However
  - reduced power in 30 s all-out cycling
  - reduction in glycolytic energy
  - not compensated for by anaerobic alactic or aerobic metabolism.
- Caution! warm-up eliciting improved oxygen utilisation may not compensate for reduced anaerobic glycolytic energy

PORTABLE MEASUREMENTS ON MUSCLE: TAKE NIRS INTO REAL SPORT

Britton Chance
University of Pennsylvania

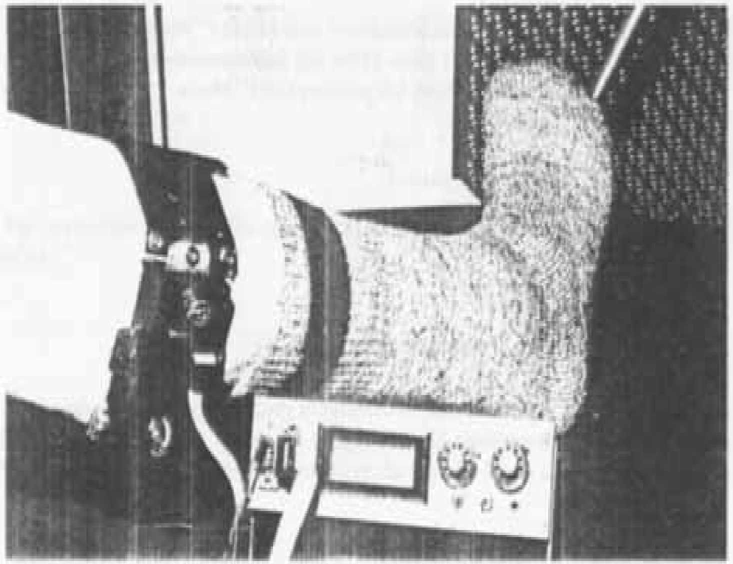


FIGURE 8. Application of a portable spectrophotometer to a human subject's leg.

1993: RUNMAN™

PORTABLE MEASUREMENTS ON MUSCLE: TAKE NIRS INTO REAL SPORT

Toshihito Katsumura, MD,PhD Dept. of Sports Medicine for Health Promotion Tokyo Medical University

DOOO


こんな疑問・・・
感じたことありませんか？
Q. 身体を動かさないと・・・
でも、どう運動すればいいの？
Q. ダイエットはしたいんだけれど・・・
運動しても長続きしないのよネ!!!
Q. 健康のためにジョギングを始めたの！
でも翌日に疲れが残っちゃって・・・
どうすれば無理なく
運動が続けられるのかしら？
自分にあった運動を知らないからです！
DooO ならあなたの目的にあった最適な運動レベルを教えてくれるので、無理のない効果的な運動やダイエットを続けられます。
DooO は、今までの万歩計やエクササイズマシーンに搭載されている計測装置とは根本的に原理が違います。あなた自身の血中酸素濃度と心拍数を計測することによって、どれだけ脂肪が燃焼しているかをリアルタイムでモニターすることができる世界初の装置です。
東京医科大学 健康増進スポーツ医学講座
勝村 俊仁 教授
これからは・・・あなたにあった運動をしませんか？
有酸素メーター DooO は、安全で効果的な運動を教えてくれる、あなただけのパーソナルトレーナーです。
3大特長
・あなたにあった有酸素運動が分かります。
・脂肪の燃焼量が分かります。
・脂肪を効率よく燃焼させ、過度な運動を防ぎます。
DooO は太ももに着けた光センサーにより、筋組織中の血中酸素濃度を正確に測定し、リアルタイムに身体の代謝状態をお知らせします。
A イヤーセンサー
B グラフィカルモニター
見やすいグラフィカルモニターを採用。
16.5
33:53
C 光センサーパッド
仕様
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DooO に関する詳しい情報は www.astem-jp.com

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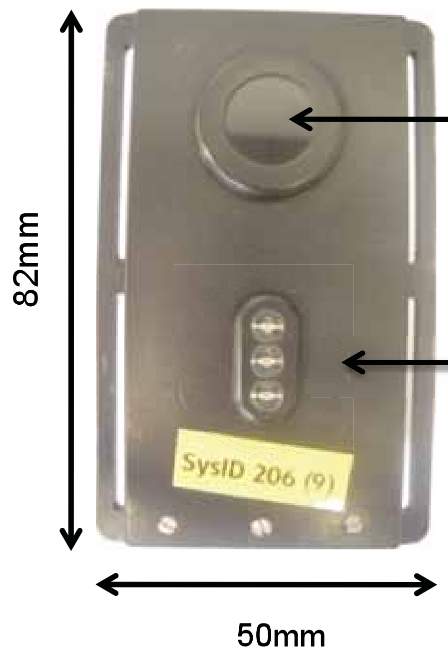
The PortaMon (Artinis Systems)

portable wireless NIRS system device



Detector

Emitters (light at wavelengths 850nm and 760nm): 30, 35, 40mm from detector

$$\text{TSI (\%)} = \frac{HbO_2}{Hb + HbO_2} \times 100$$

Tissue Saturation Index (TSI): multiple sensors at different distances allow quantitative measure of tissue oxygen saturation to be derived

Near Infrared Spectroscopy Measurements in Elite Short-track Speed Skaters During On-ice Race Simulation

Presented by: Catherine Hesford

Supervisor: Professor Chris Cooper

In Summary....

- First study of the asymmetry of oxygenation in short-track speed skating

- Clear differences between the right and left leg during 500m race simulation

- Differences are evident over a single lap, and also cumulatively over the course of a whole race simulation

- Potential performance implications of such a finding?

With thanks to:

- Catherine Hesford
- The Great Britain Short Track Speed Skating Squad and Coaching Staff
- Artinis Medical Systems
- Dr Stewart Laing
- Dr Marco Cardinale and BOA for funding