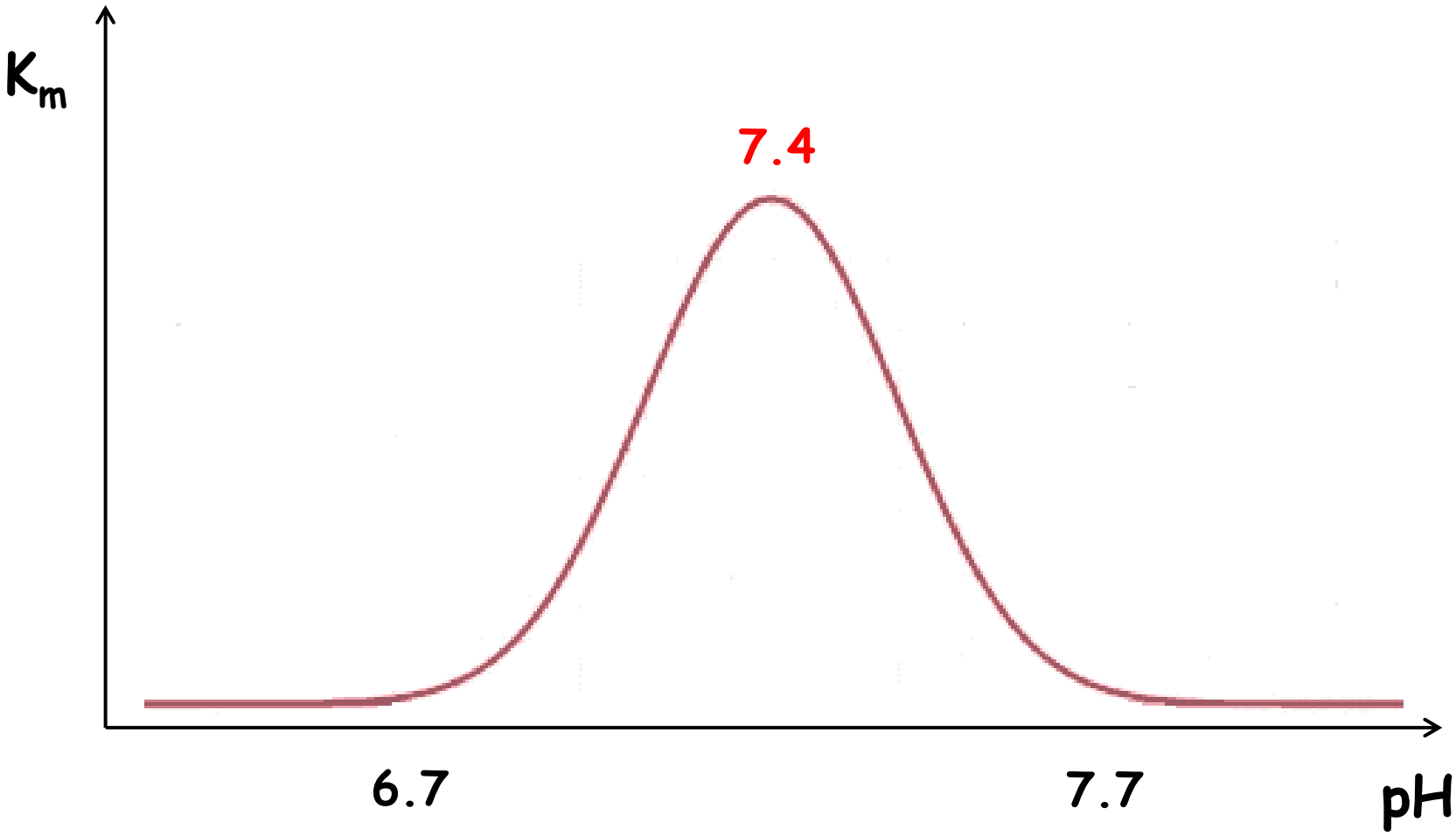
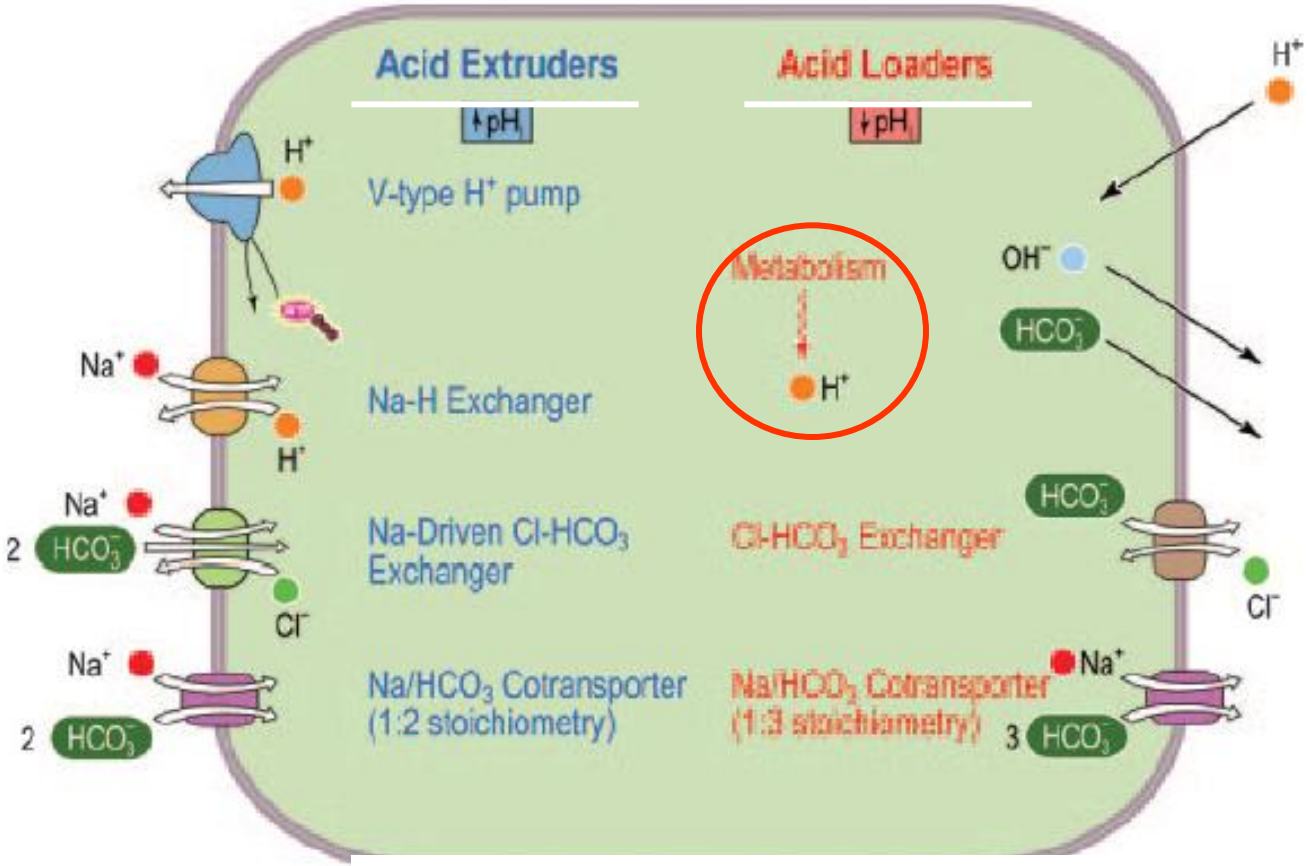
pH, always pH

F.Schiraldi
Medicina d'Urgenza Osp.S.Paolo
Napoli

IS A NEAR-NORMAL pH IMPORTANT ?



EXTRUDERS VS LOADERS



Report

Adv Physiol Educ 28: 160–179, 2004;
doi:10.1152/advan.00045.2004.

REFRESHER COURSE | *Cellular Homeostasis*

Regulation of intracellular pH

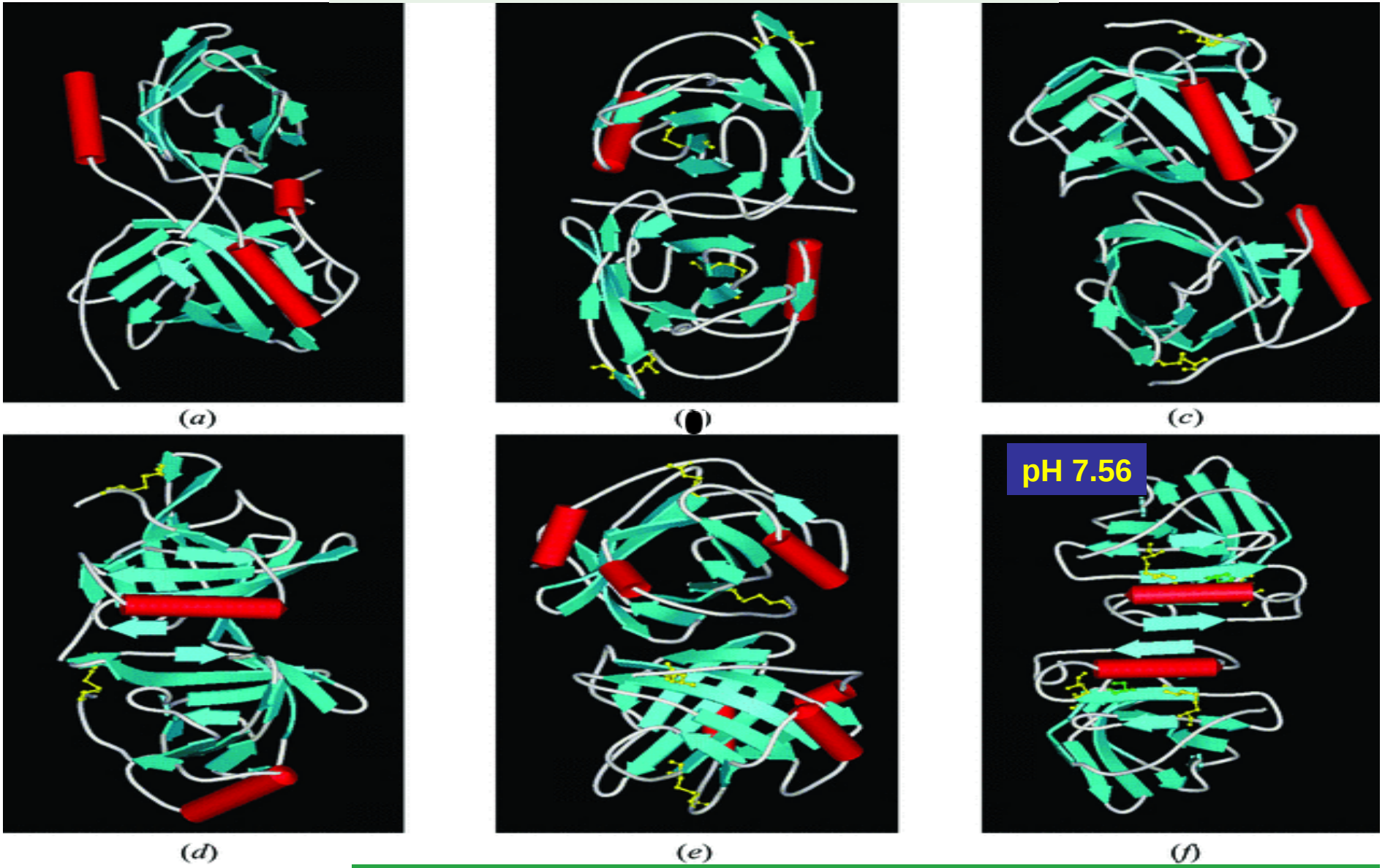
Walter F. Boron
Department of Cellular and Molecular Physiology, Yale University School of Medicine, New Haven, Connecticut 06520-8026

Received 13 September 2004; accepted in final form 17 September 2004

pH 7.4

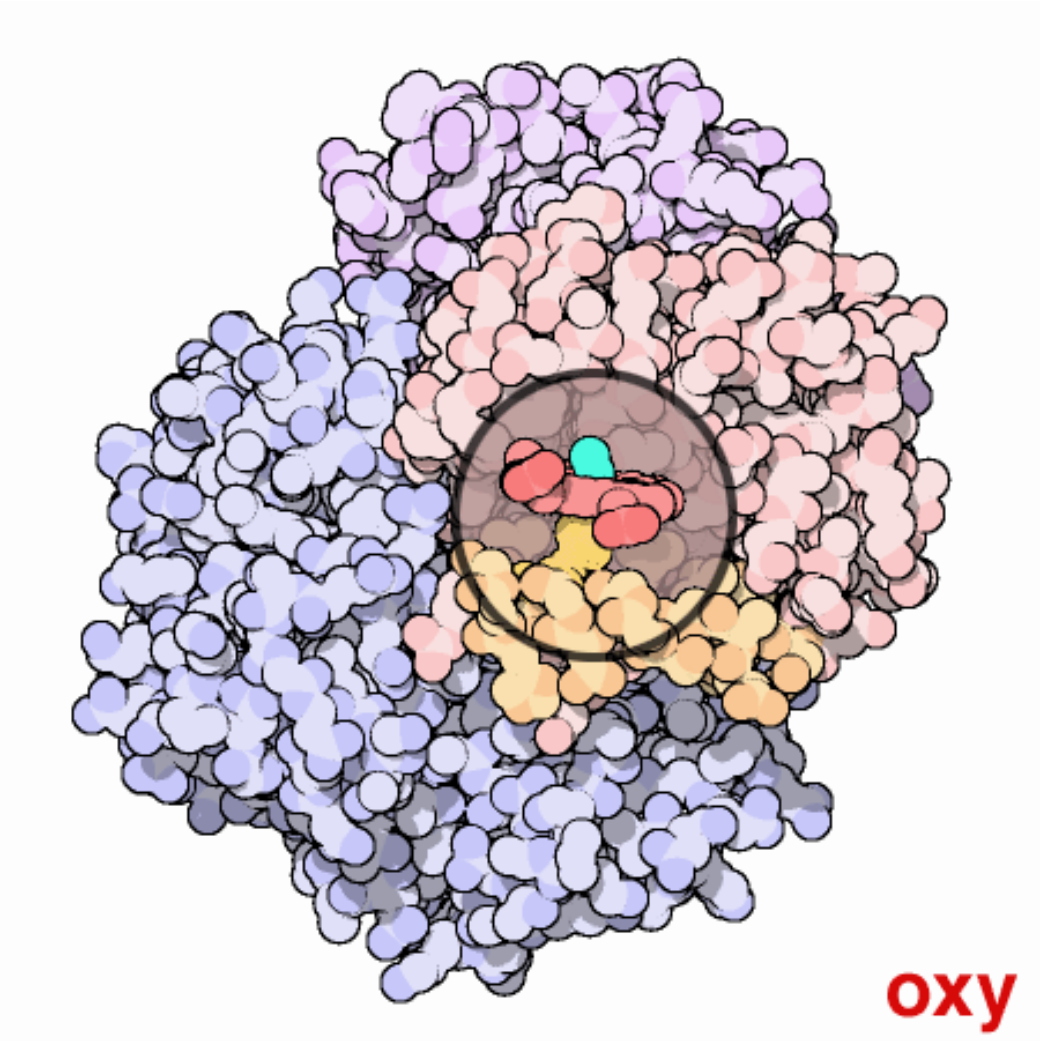
Intracellular pH Sensors: Design Principles and Functional Significance

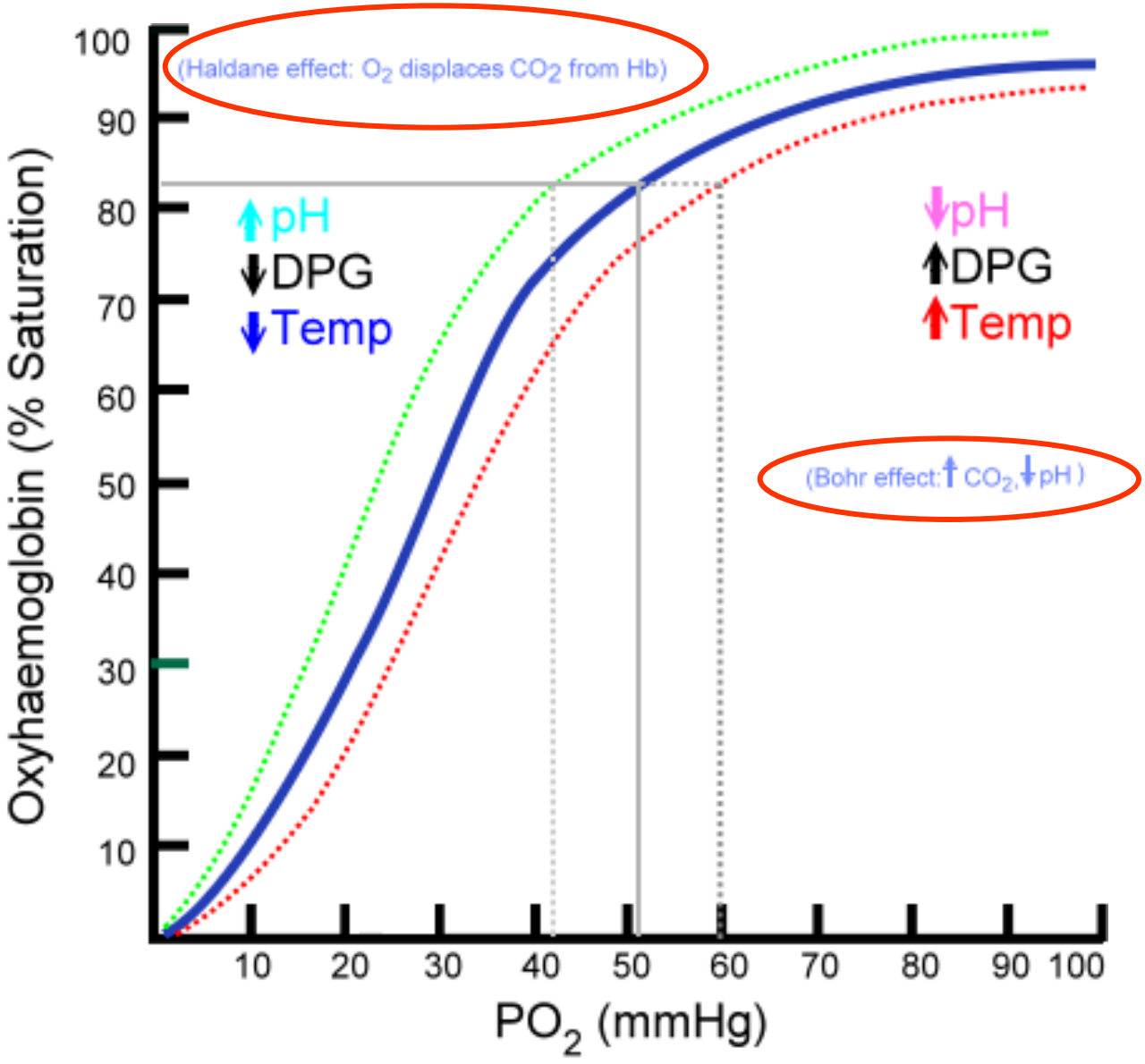
pH 6.9



PHYSIOLOGY 22: 30–39, 2007; 10.1152/physiol.00035.2006

THE Hb “FLEXIBILITY”




(Haldane effect: O_2 displaces CO_2 from Hb)
↑pH
↓DPG
↓Temp
↓pH
↑DPG
↑Temp
(Bohr effect: ↑ CO_2, ↓pH)
Oxyhaemoglobin (% Saturation)
100
90
80
70
60
50
40
30
20
10
10 20 30 40 50 60 70 80 90 100
PO_2 (mmHg)

WHICH ARE THE MAIN pH DETERMINANTS ?

H^+ PRODUCTION vs { Renal handling ; Alveolar ventilation }

plus

Alb, Phosf, Sulf, Na, K, Cl, Mg, Ca, Lact, Krebs intermediates and…….

Water dissociation

The $[H^+]$ vs pH paradox

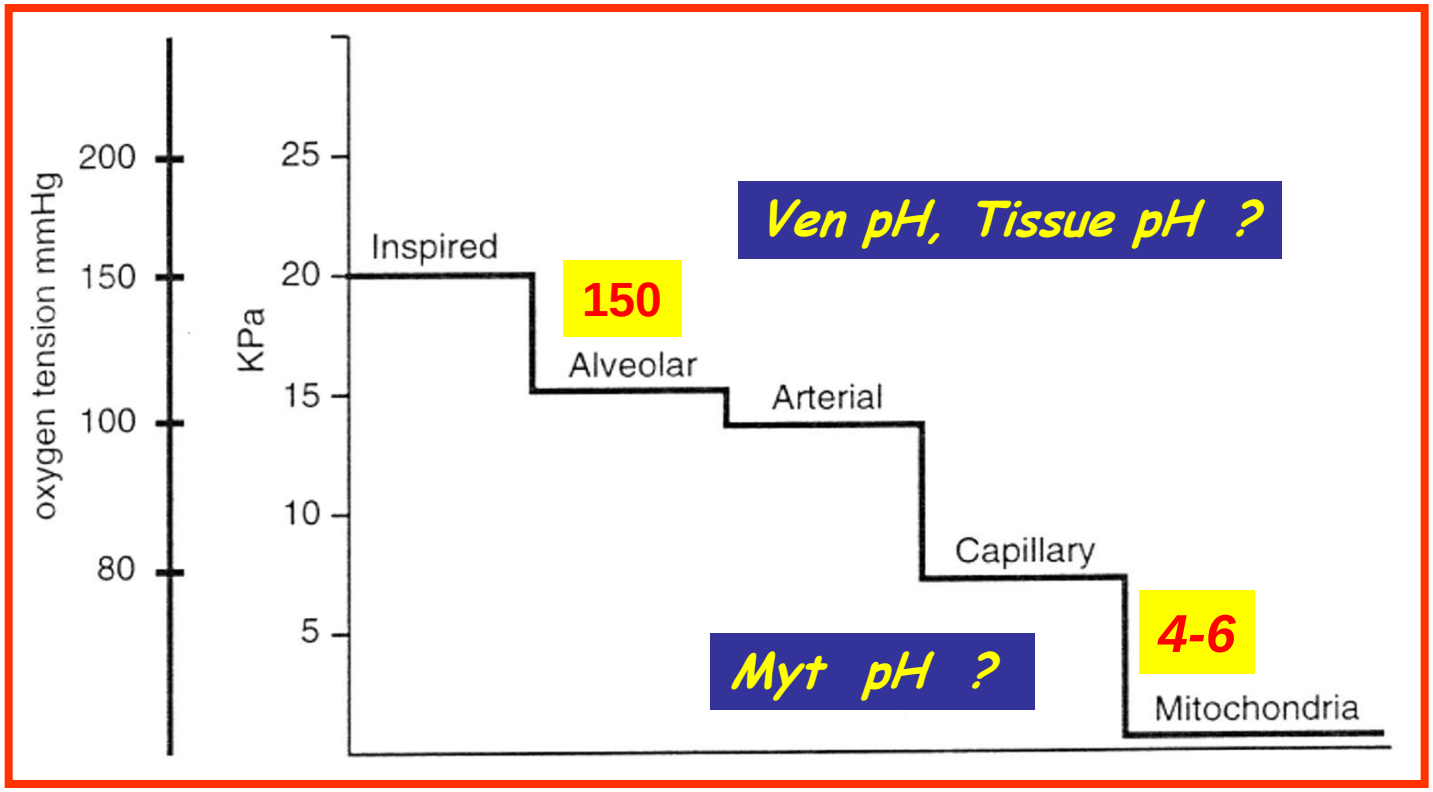
pH 7.4 = $[H^+]$ 40 nmol/L

pH 7.2 = $[H^+]$ 63 nmol/L

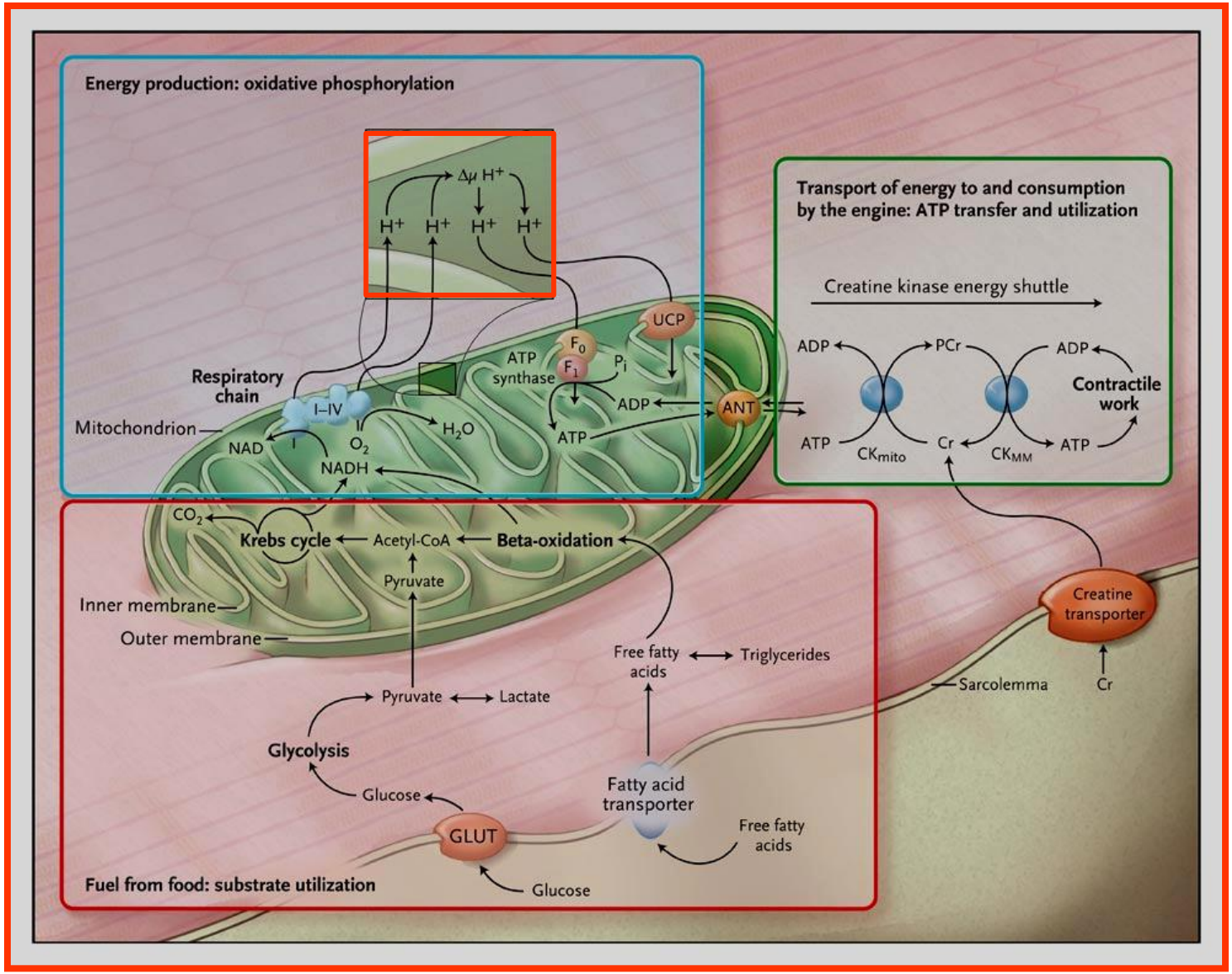
pH 7.0 = $[H^+]$ 100 nmol/L

Delta pH 5% = Delta $[H^+]$ 150%

THE PO_2 & pH ANALOGY



HF = AN ENGINE OUT OF FUEL



The NEW ENGLAND JOURNAL of MEDICINE

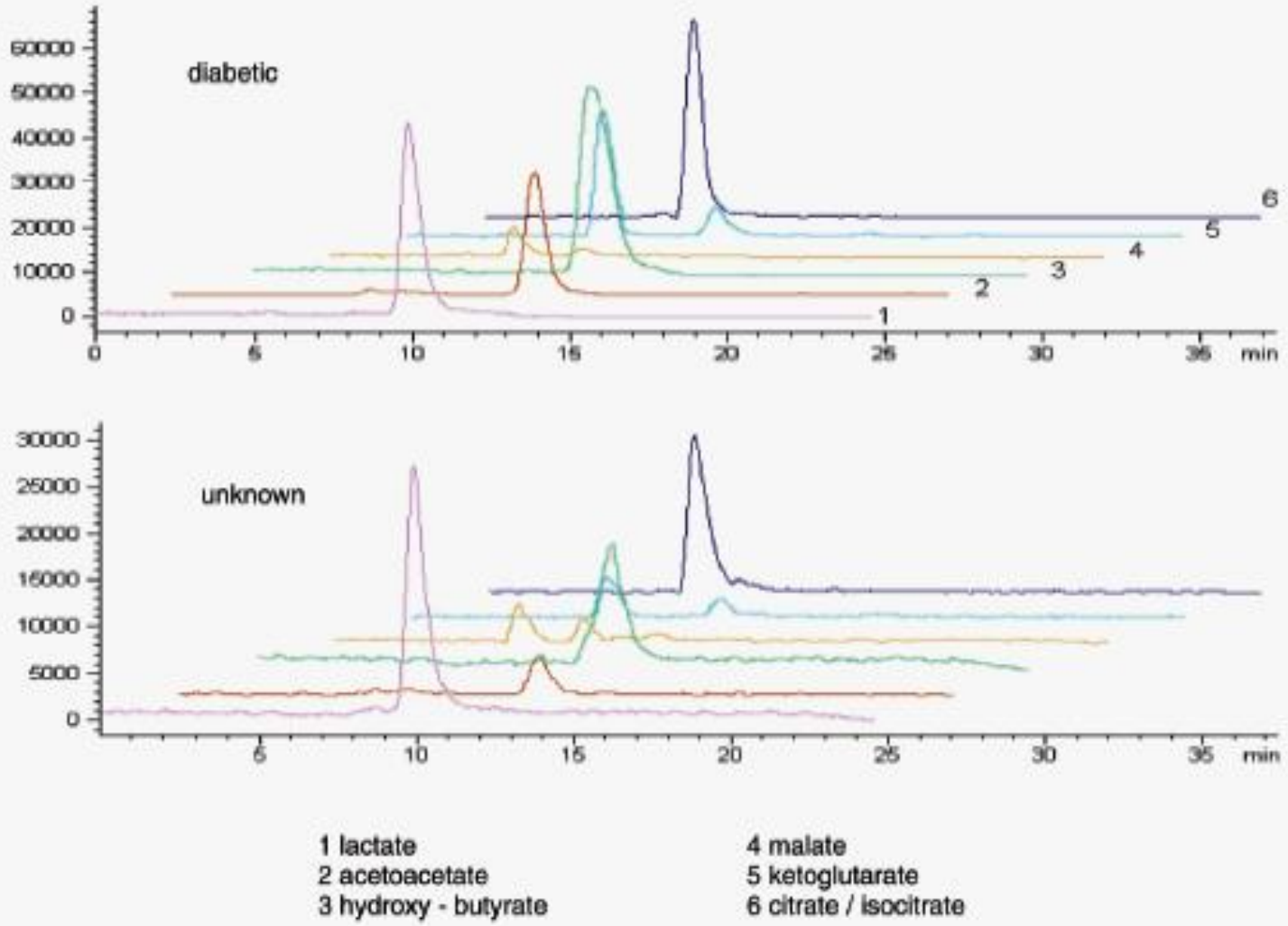
356:1140 (2007)

Review

Unmeasured anions in metabolic acidosis: unravelling the mystery

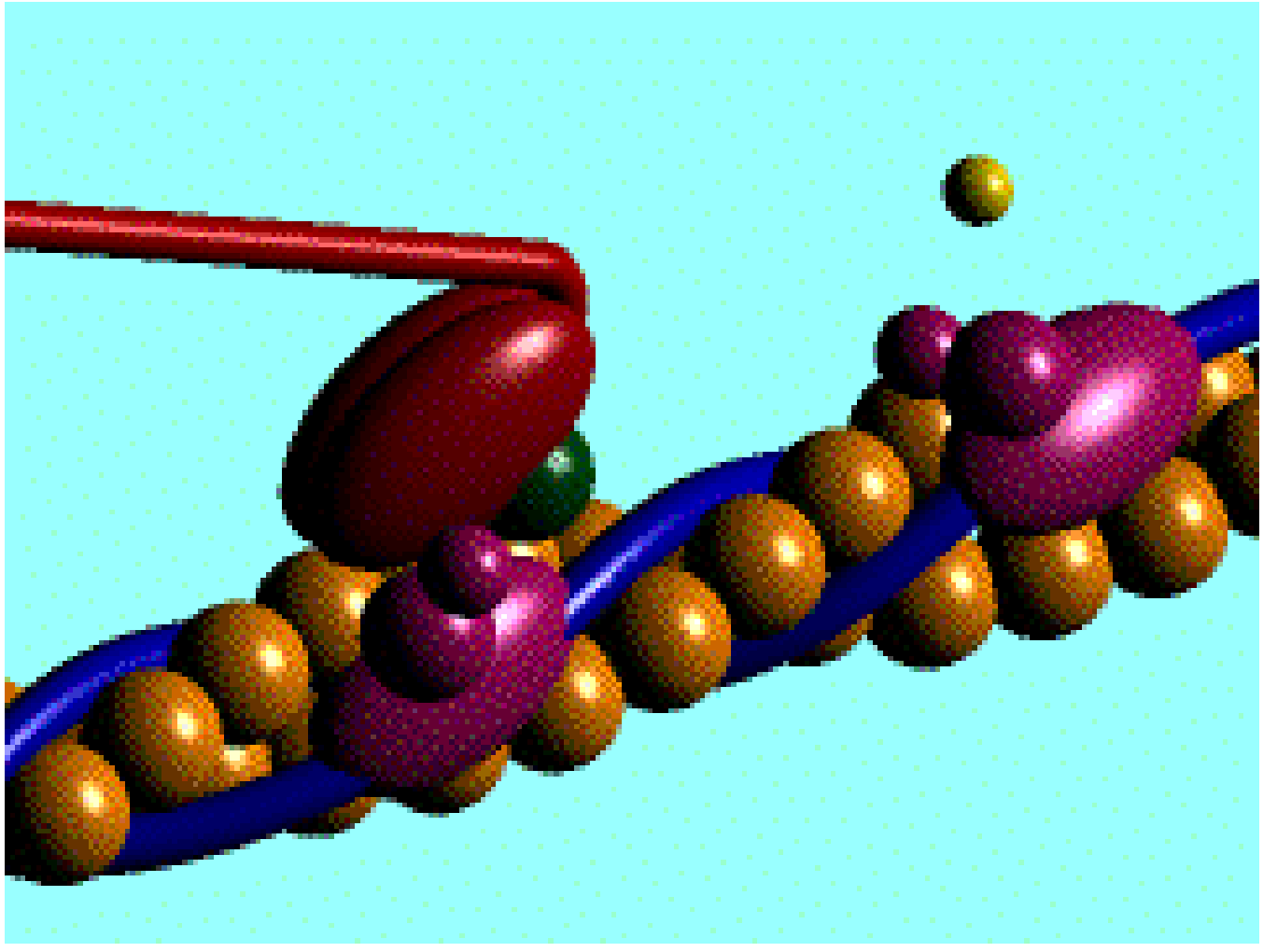
Lui G Forni[1,2], William McKinnon[3] and Philip J Hilton[3]

Critical Care 2006, **10**:220 (doi:10.1186/cc4954)



IS A NEAR-NORMAL pH IMPORTANT ?

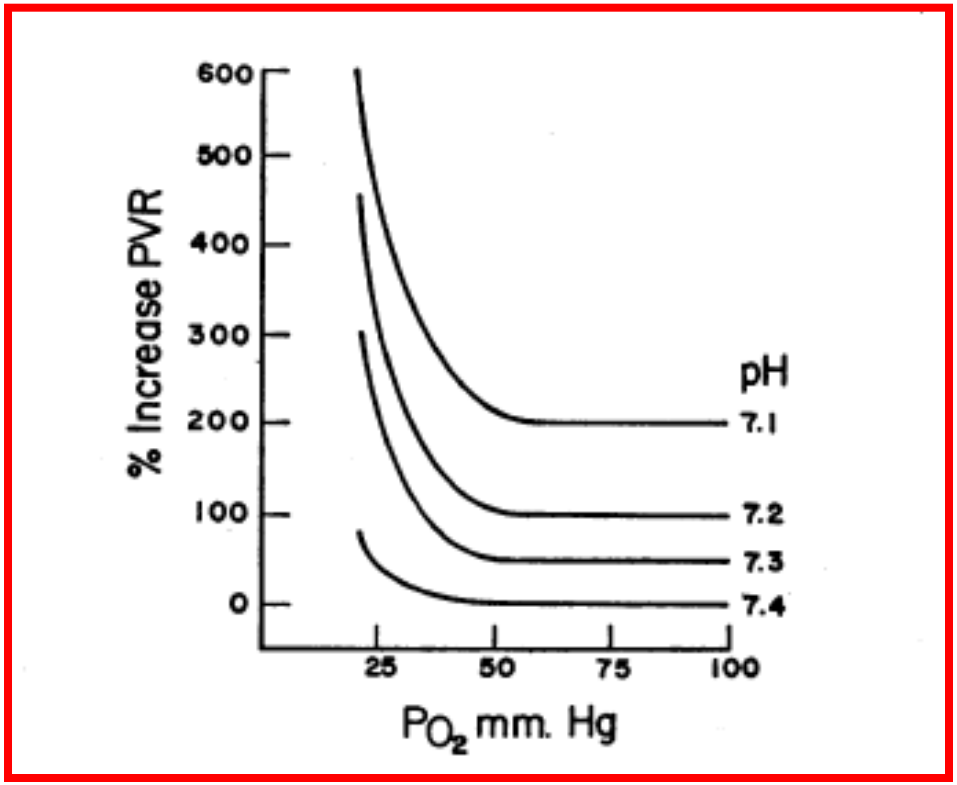
H^+ vs Ca^{++} & troponins



Journal of Clinical Investigation
Vol. 45, No. 3, 1966

Response of the Pulmonary Vasculature to Hypoxia and H^+ Ion Concentration Changes *

ABRAHAM M. RUDOLPH † AND STANLEY YUAN



Molecular and Cellular Biochemistry **263:** 163–172, 2004.

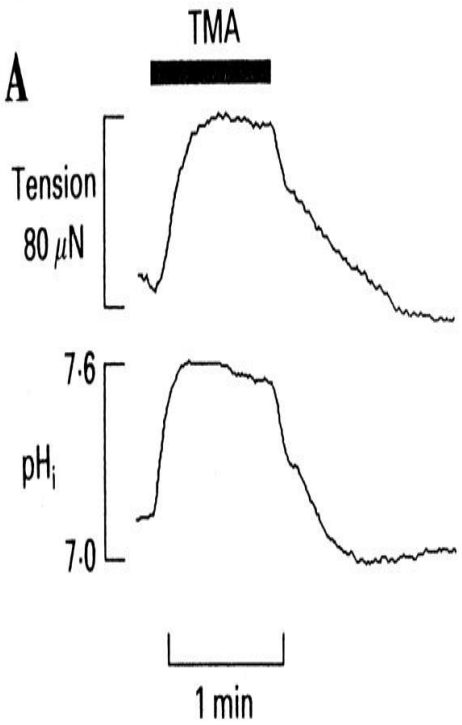
Mechanisms of action of pH-induced effects on vascular smooth muscle

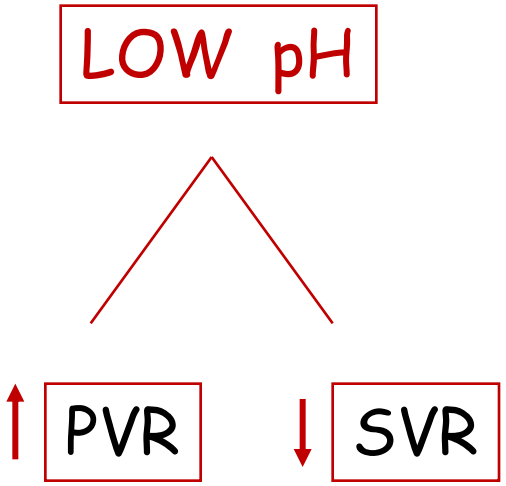
Susan Wray and R.D. Smith
The Physiological Laboratory, The University of Liverpool, Liverpool, UK

Abstract

It is clear that pH has many effects on vascular smooth muscle and the overall action of pH on force will depend on the type of vascular smooth muscle in question and the combined effects on all the potential modulatory mechanisms. The major effects of pH on force appear to be mediated via modulation of $[Ca]_i$ rather than changes in the sensitivity of the contractile machinery to Ca^{2+}. There are still numerous gaps in our understanding of the actions of pH and as more data become available, we will be able to better understand the major mechanisms involved. (Mol Cell Biochem **263:** 163–172, 2004)

Key words: acidity, calcium, contraction, force, ionic currents, signalling

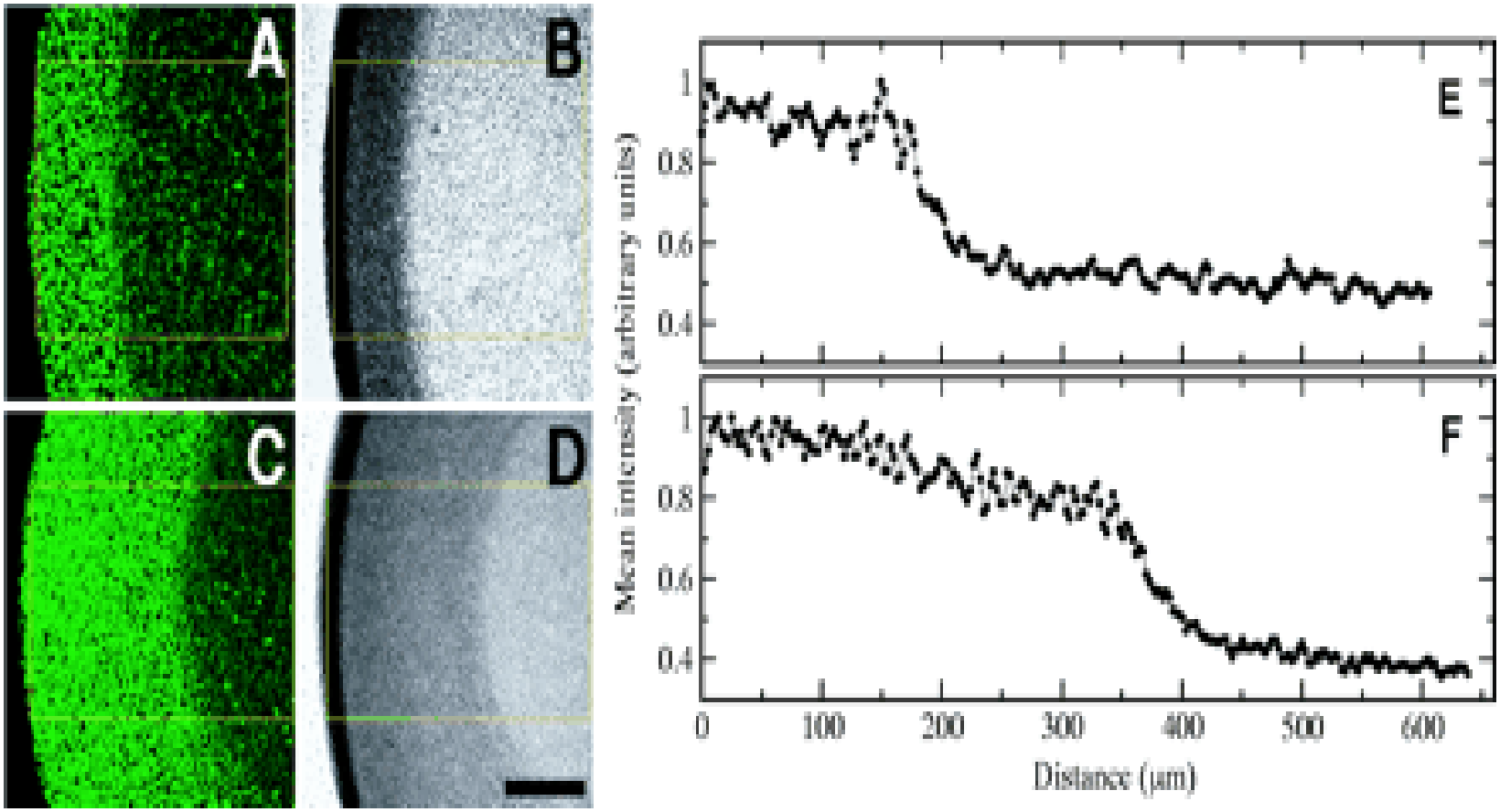




	RIGHT HEART		LEFT HEART	
	normal	failing	normal	failing
↓ pH	++	+++	±	±
hypoxemia	++	++++	±	±

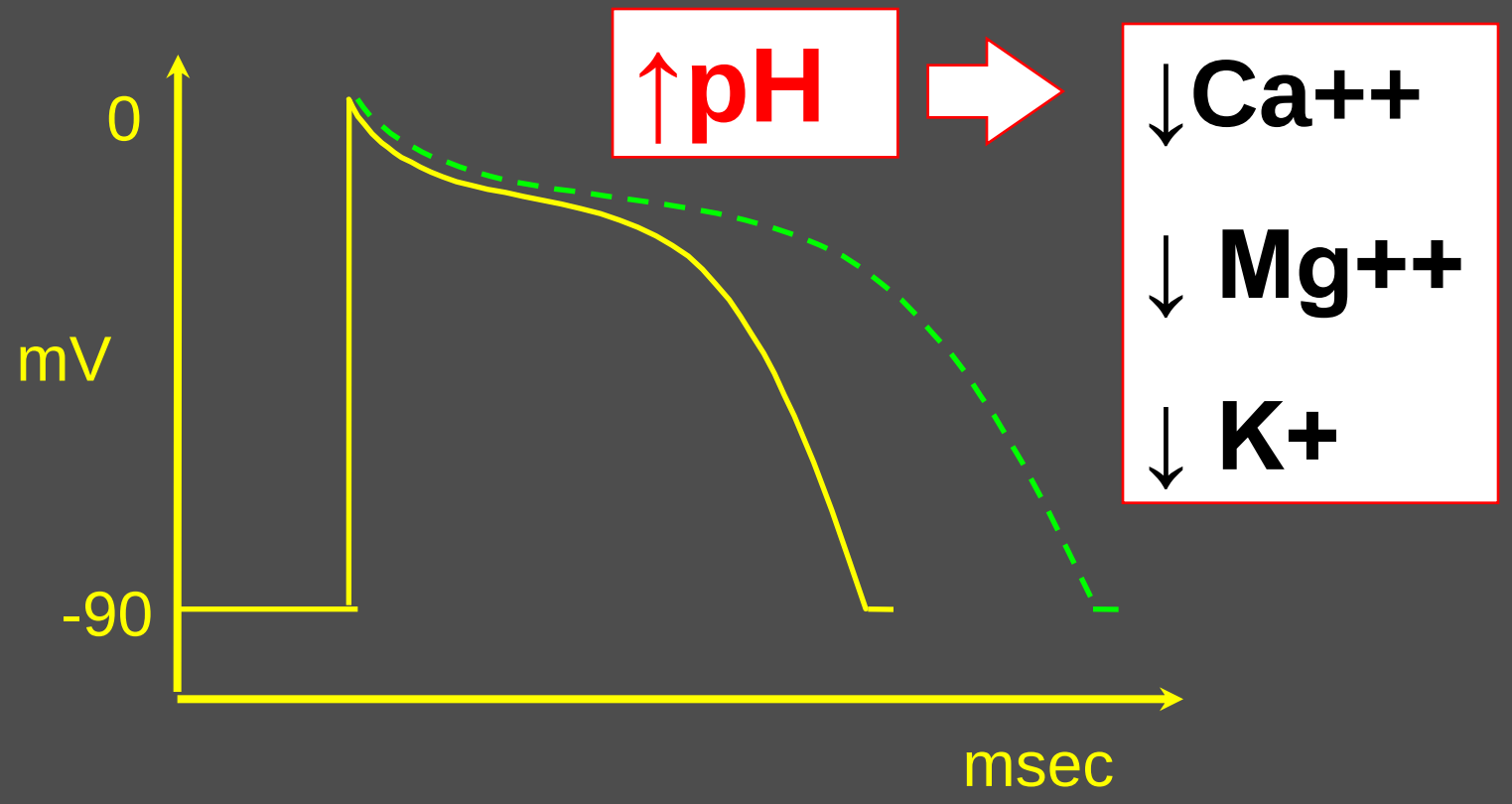
JJ Marini, AP Wheeler Critical Care 2010

↑↑ DO2 PROTECTS AGAINST ACID LOADING

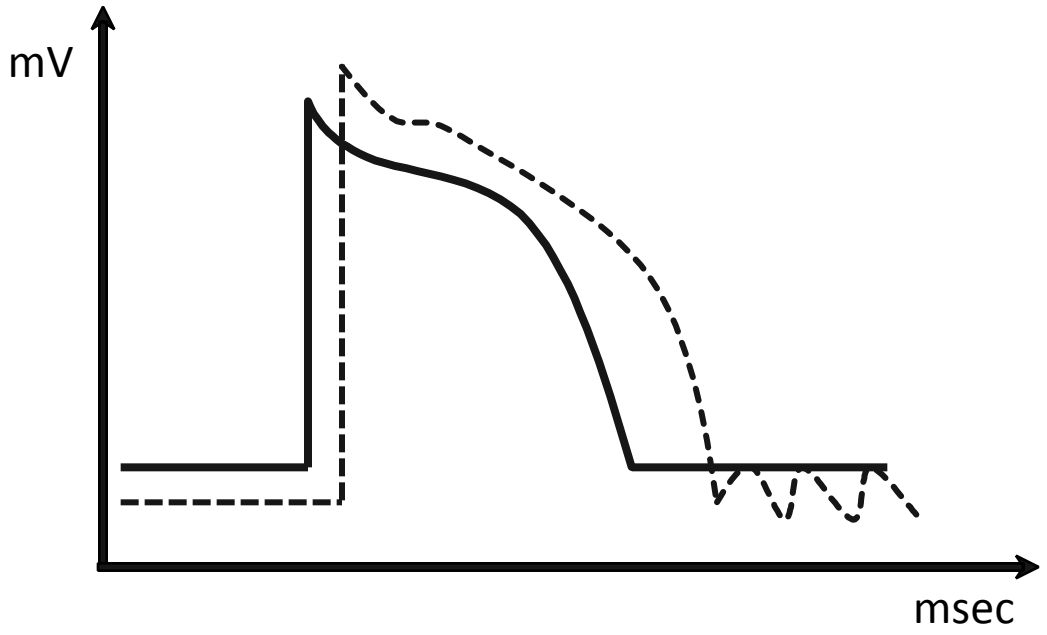


K SAWAJ (2004) JEB ;205:17-23

Arrythmogenic effects of alkalemia



Ipokaliemia



↑ resting potential	↓ gK
↑ phase 0: high amplitude QRS **↑ conduction velocity:** nerrow QRS	**phase 3 prolongation:** long QT small T wave U wave *"dispersed repolarization"*

pH vs PCO_2

	acute	"mixed"	chronic
pH	7.22	7.25	7.32
PCO_2	70	70	70
HCO_3	28	30	35

pH vs PCO_2

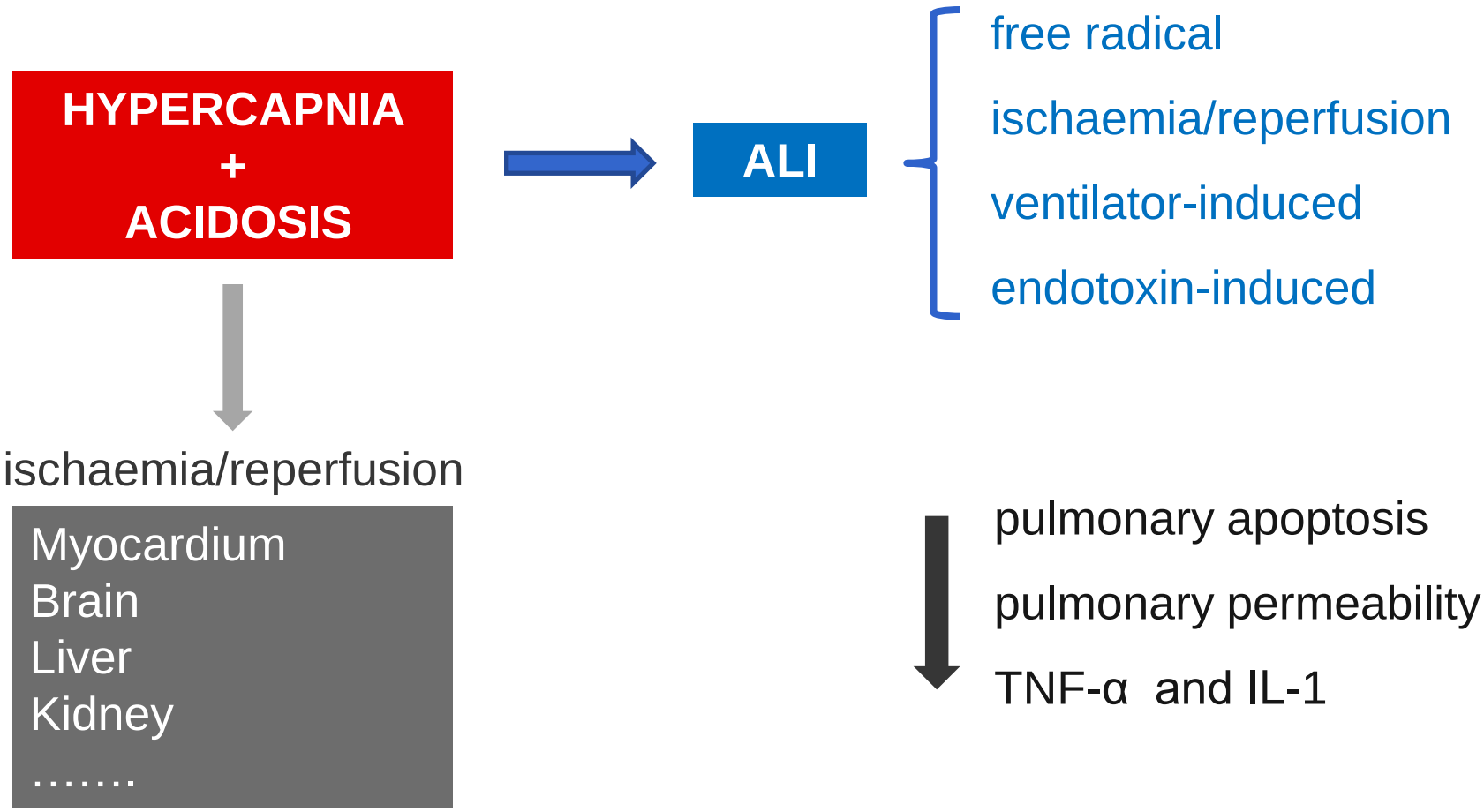
"mixed"

pH	7.08
PCO_2	70
HCO_3	20

Review

Bench-to-bedside review: Permissive hypercapnia

Donall O' Croinin[1], Martina Ni Chonghaile[2], Brendan Higgins[3] and John G Laffey[4]



Critical Care 2005, 9:51-59

↓↑ pH «permissivity»?

Low pH

- ↓ BP
- ↓ CO
- Stroke
- Head trauma
- Hyperkalemia
- Toxic……

but…think of mixed acidosis

High pH

- Weaning troubles
- Arrhytmias/Drugs
- Hypo K,Mg,Ca
- Hypoxia
- ……

but…think of mixed alkalosis

pH in ventilated patients

Too high

- difficult weaning
- arrhythmias
- low PtO2

Too low

- diaphragmatic fatigue in NIV
- underperfusion
- renal insufficiency

VIEWPOINT

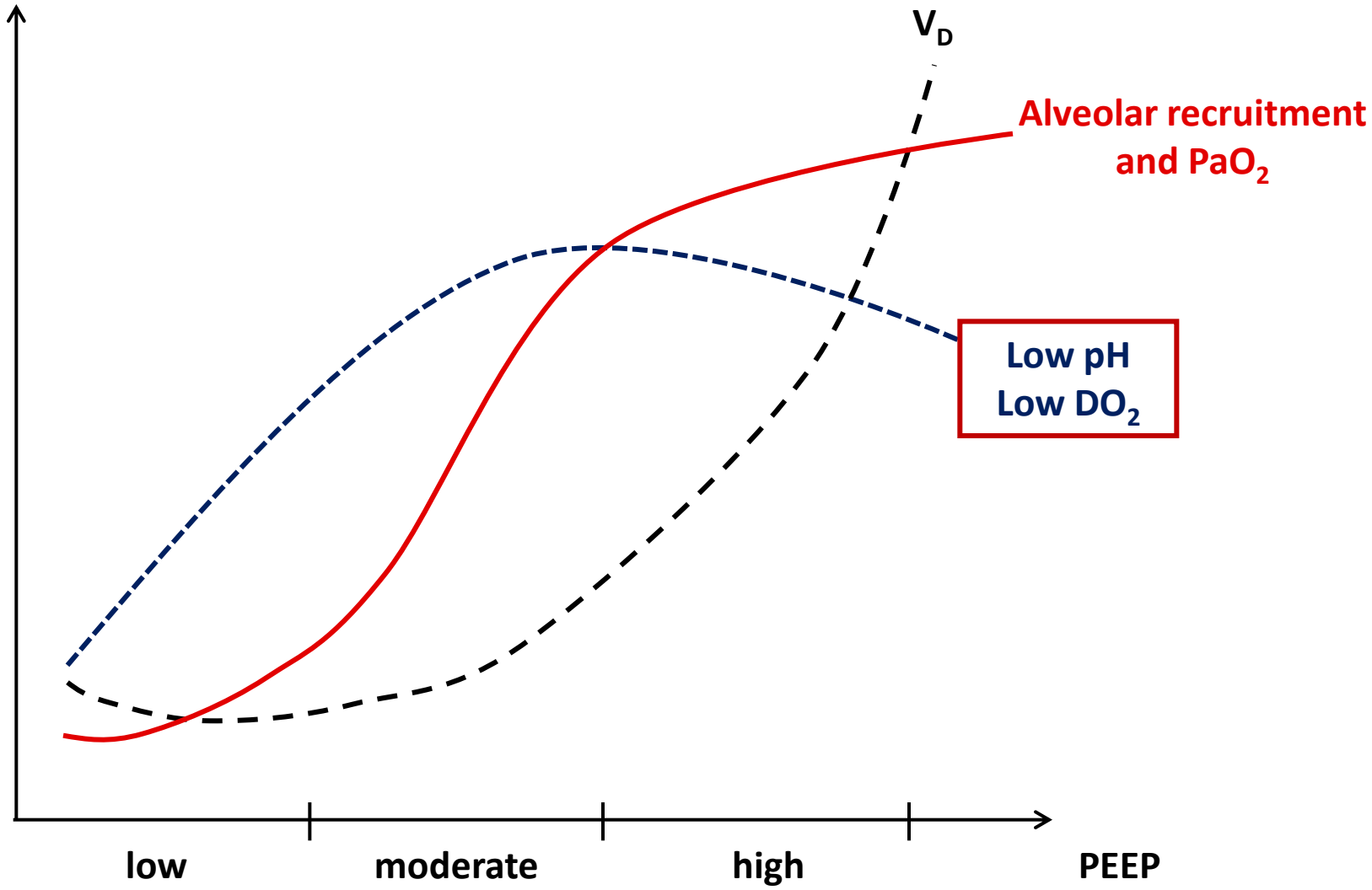
Acetazolamide: a second wind for a respiratory stimulant in the intensive care unit?

Nicholas Heming*[1], Saïk Urien[2] and Christophe Faisy[1]

CRITICAL CARE 2012

Alkaline diuresis induced by acetazolamide is maximized at 24 hours and is associated with a urinary loss of bicarbonate of about 4 to 6 mmol/L, which in turn induces a **decrease of blood pH by 0.05 to 0.1 units**. The resulting metabolic acidosis stimulates peripheral and central chemoreceptors **associated with an increase in minute ventilation.**

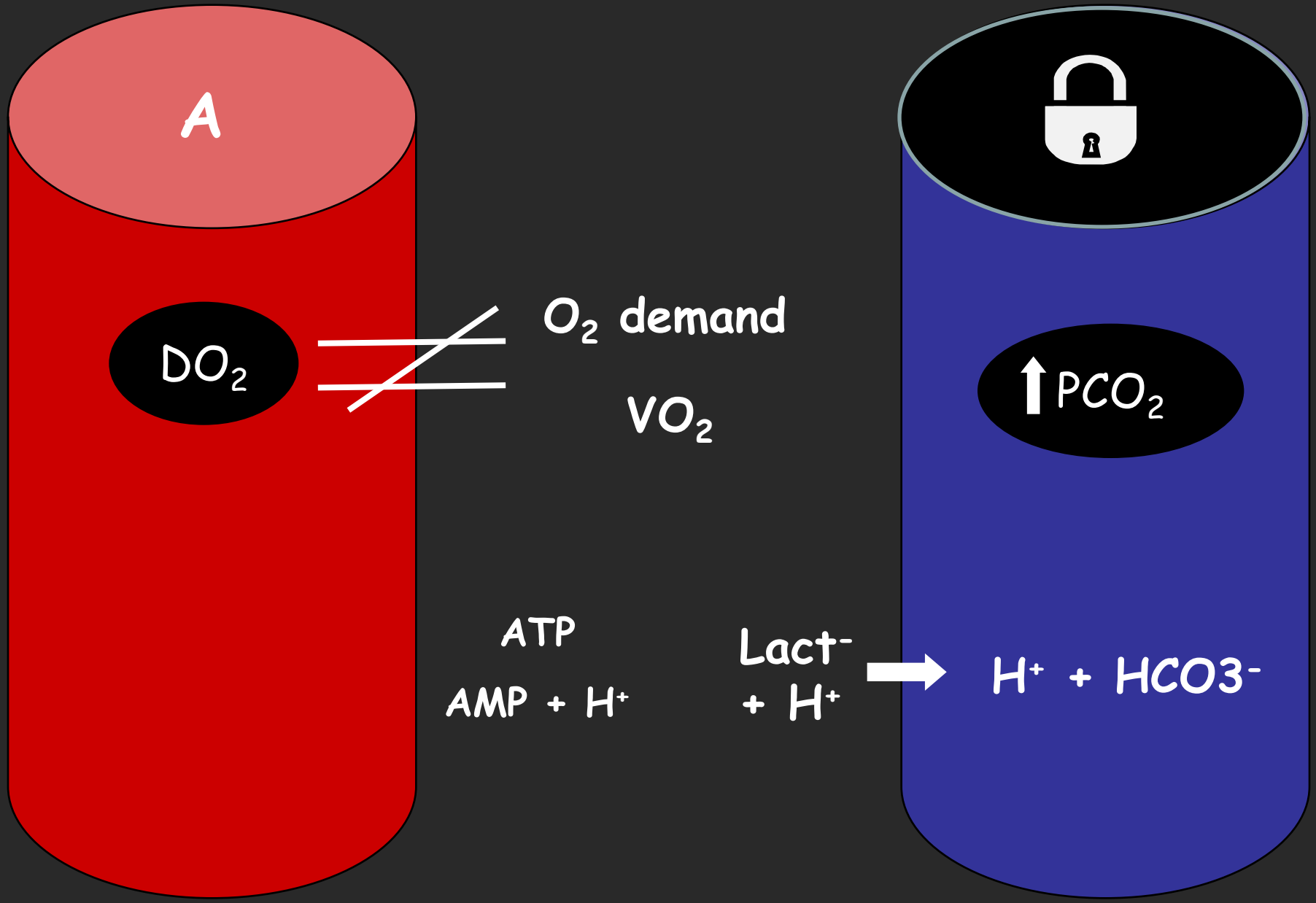
THE BEST PEEP



"VENOUS METABOLIC ACIDOSIS" (↑↑ $P_{cv}CO_2$)

Arieff, Weil, Gattinoni, Adroguè, Pinsky…….

The CO_2 lung presentation & low flow

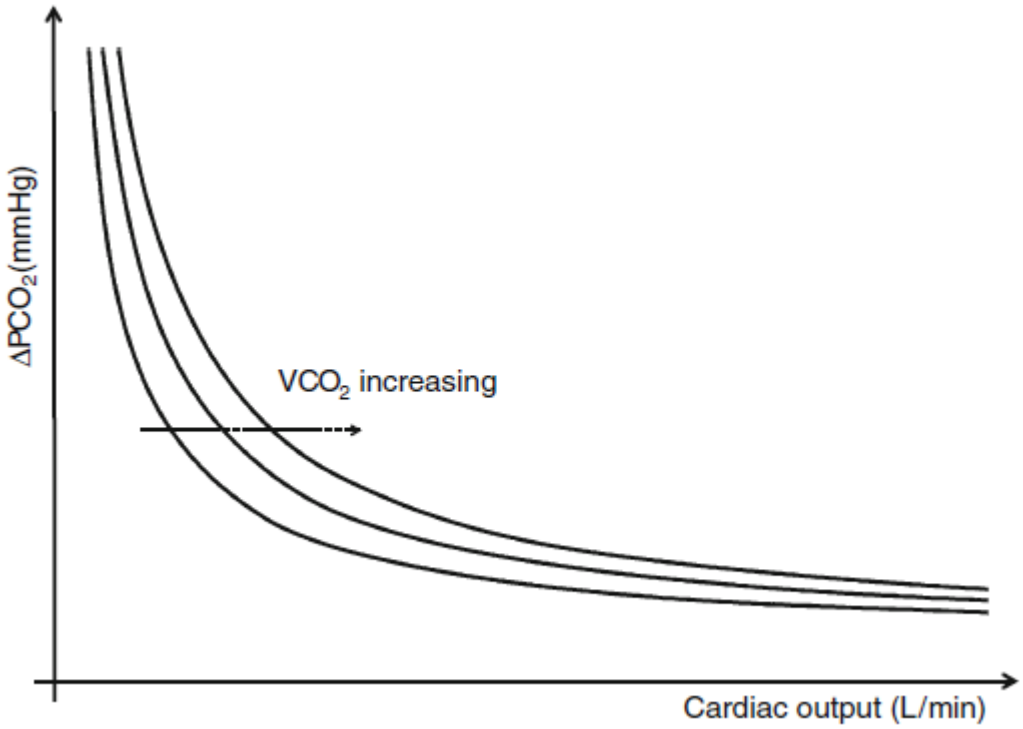


J Clin Monit Comput (2012) 26:367–374
DOI 10.1007/s10877-012-9381-x

INVITED REVIEW

Hemodynamic management of cardiovascular failure by using PCO_2 venous-arterial difference

Martin Dres · Xavier Monnet · Jean-Louis Teboul

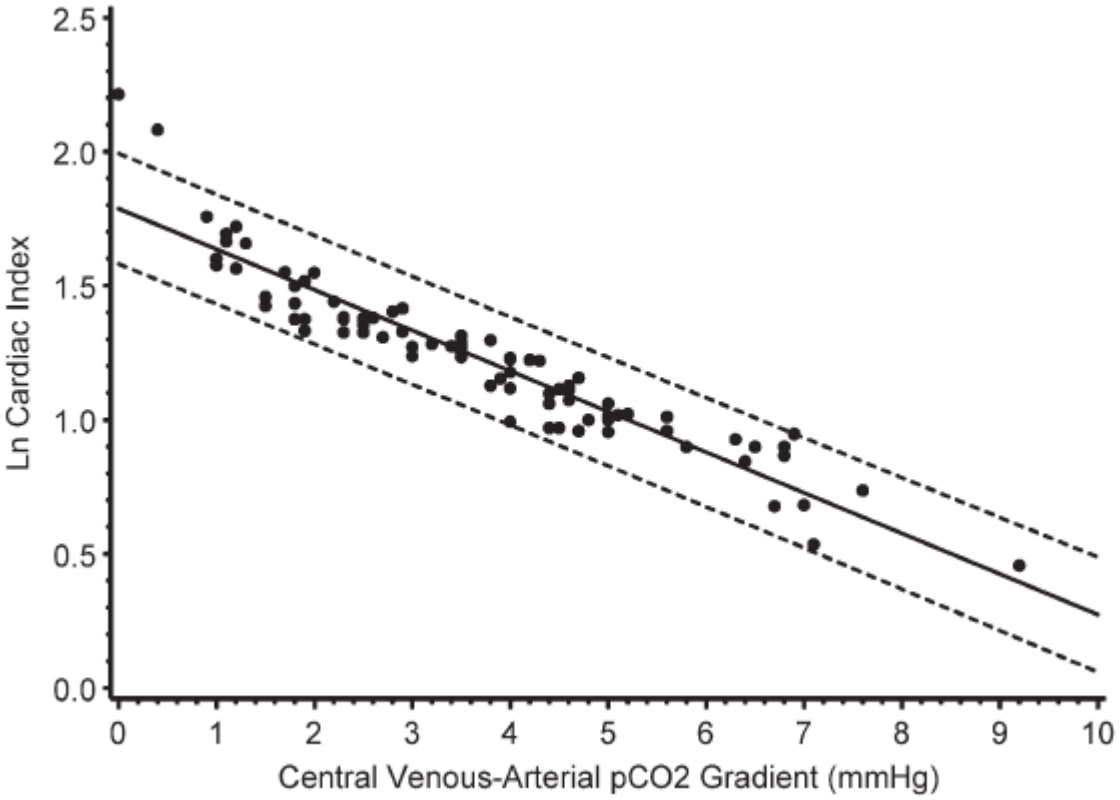


Intensive Care Med (2005) 31:818–822
DOI 10.1007/s00134-005-2602-8

ORIGINAL

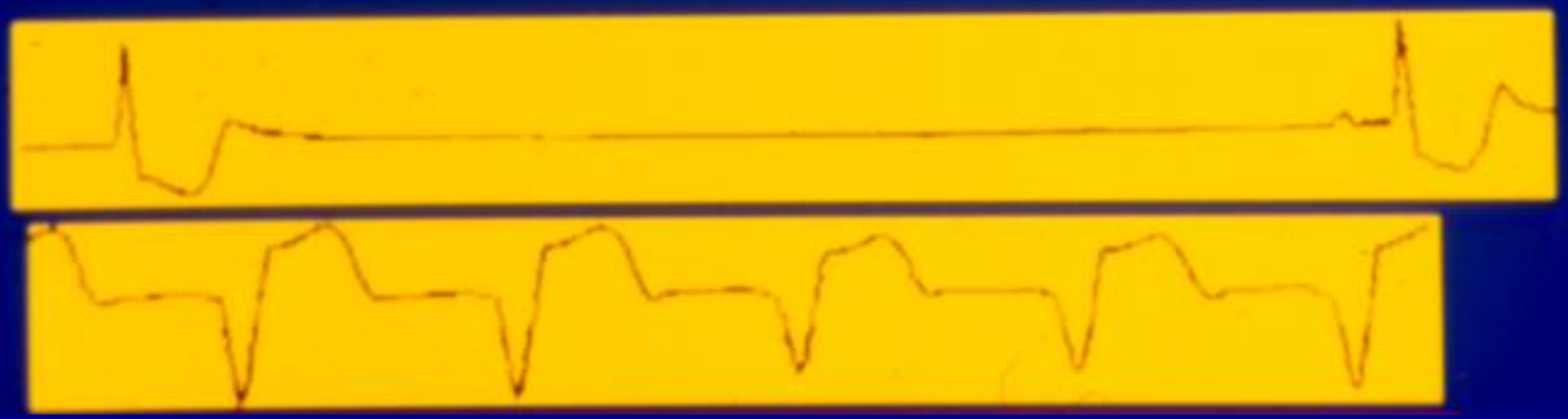
Joseph Cuschieri
Emanuel P. Rivers
Michael W. Donnino
Marius Katilius
Gordon Jacobsen
H. Bryant Nguyen
Nikolai Pamukov
H. Mathilda Horst

Central venous-arterial carbon dioxide difference as an indicator of cardiac index



P.R. 69 y.♀ 17th OCt 1992

	h. 12.15 art.	h. 12.15 c.ven.		h. 12.30 art.	h. 12.30 c.ven.	
pH	7.14	7.114		7.440	7.393	
PCO_2	30.9	40.1	ΔCO_2 = 9.2	34.7	40	ΔCO_2 = 5.3
PO_2	199.6	45.3		75.3	31.7	
HCO_3	11.8	12.2		23.3	24	
SAT	99.1	63.2	OER = 36	94.5	61.4	OER = 33.5



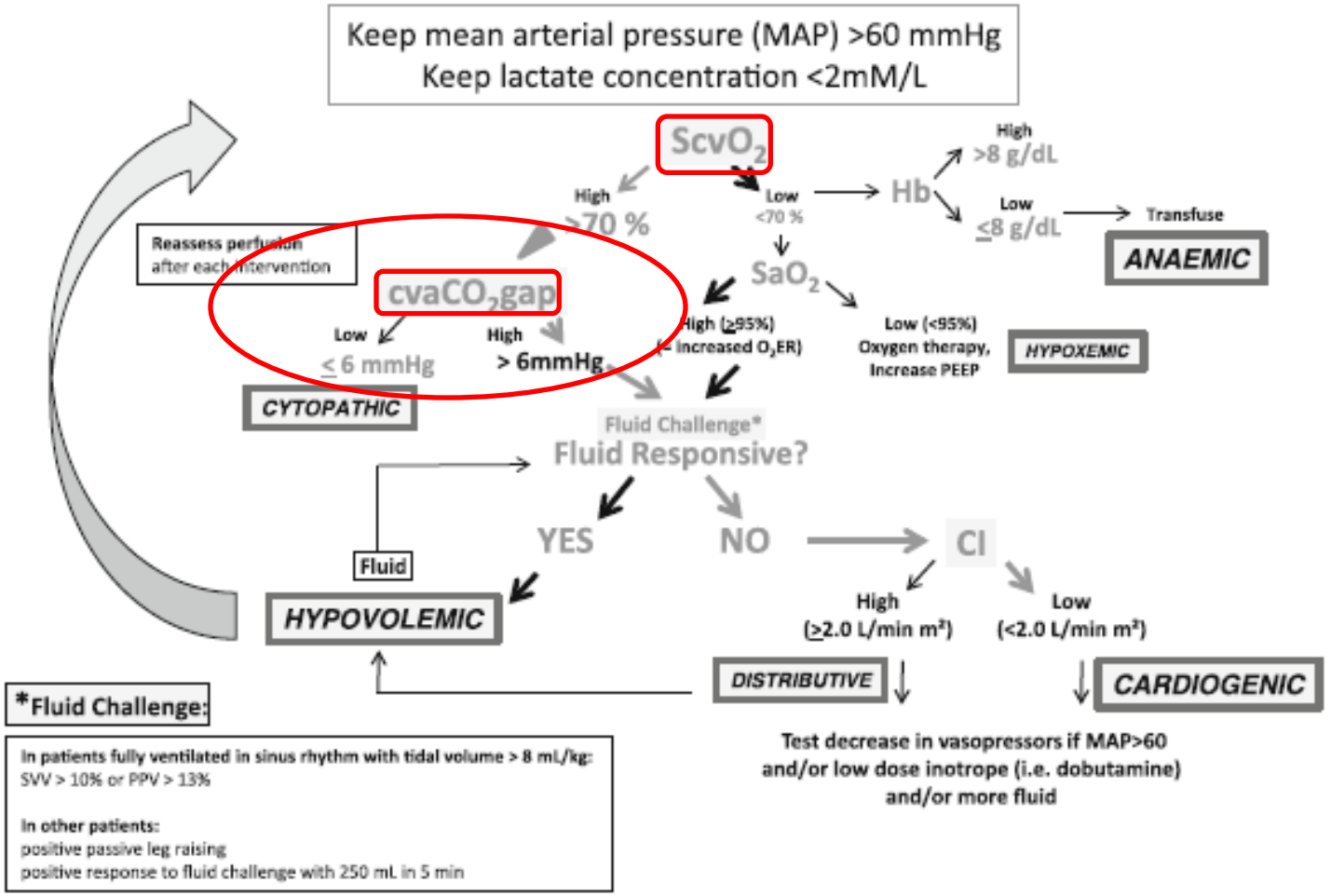
FS 1993

Intensive Care Med (2013) 39:1653–1655
DOI 10.1007/s00134-013-2998-5

EDITORIAL

B. Vallet
M. R. Pinsky
M. Cecconi

Resuscitation of patients with septic shock: please "mind the gap"!



$$\frac{VO_2}{DO_2} \div ScvO_2 + \text{low pH} = O_2 \text{ debt}$$

$$\frac{O_2 \text{ Demand}}{DO_2} + \text{low pH} = \text{lactic acidosis}$$

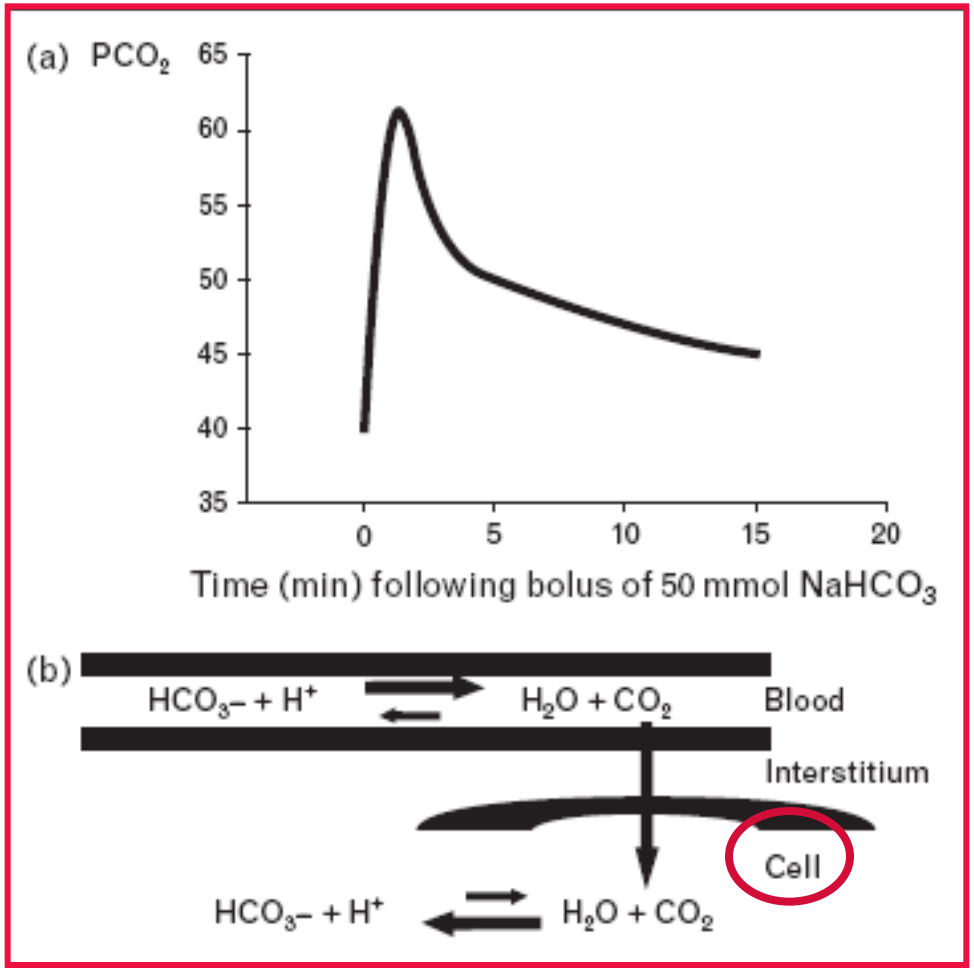
$$\frac{VCO_2}{\text{flow}} \div \Delta_{va}PCO_2 + \text{low pH} = \text{tissue acidosis ?}$$

$$\downarrow \text{micro-flow} \div \Delta_{ta}PCO_2 = \text{the future...?}$$

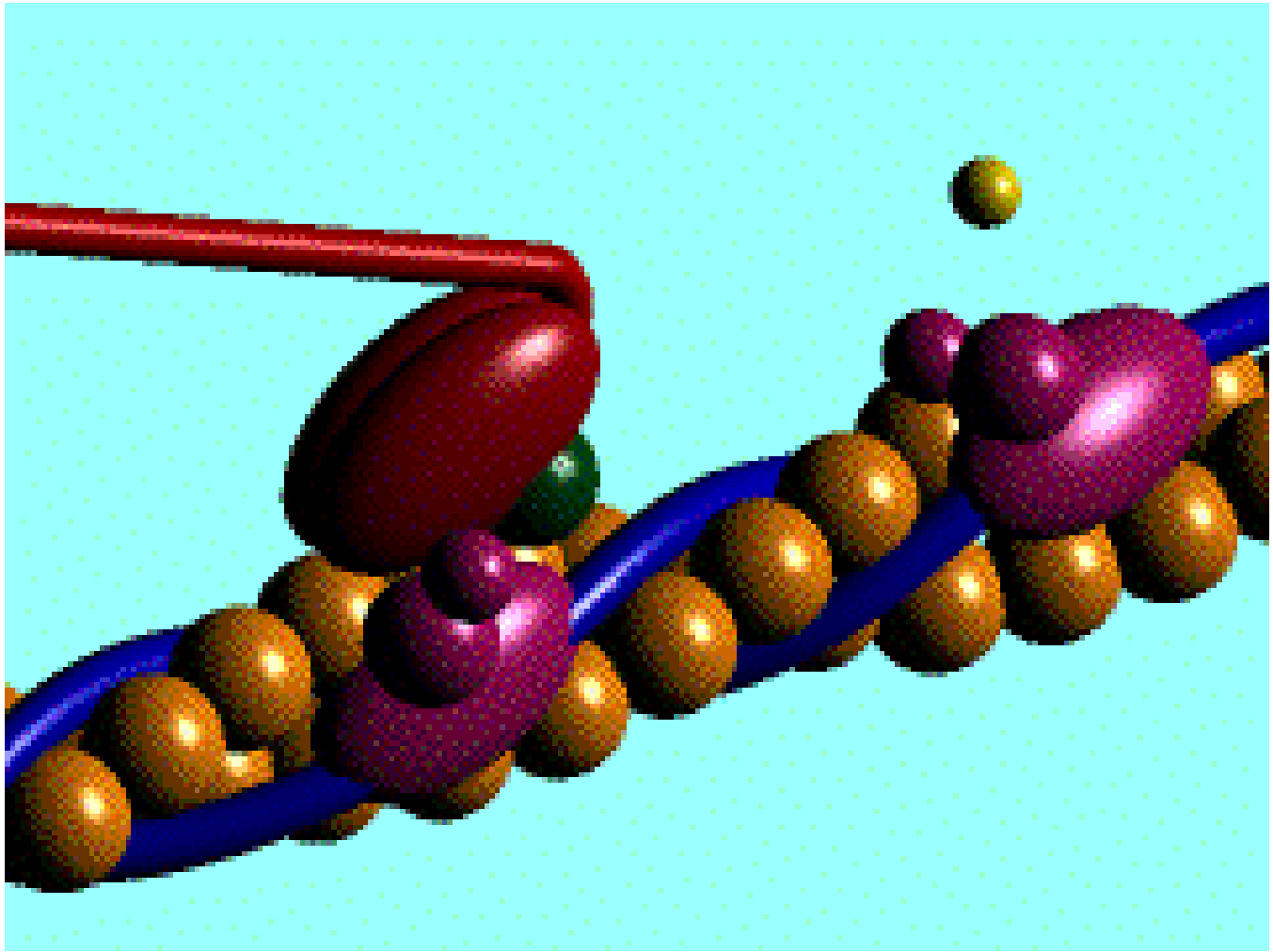
Is there a role for sodium bicarbonate in treating lactic acidosis from shock?

John H. Boyd and Keith R. Walley

Current Opinion in Critical Care 2008, 14:379–383



H^+ vs Ca^{++} & troponins



The case for bicarbonate

- Losses
- Hyperkalemia
- Toxic
- Uremia
- DKA ?
- Dye
- ……

KEY POINTS

- pH is a finely tuned ratio (MET/VENT)
- pH_i more relevant than pH_o
- If alkalemic think of Fluids & Electrolytes
- If acidemic and normoperfused, consider Alkali or CRRT (rhabdomyolysis, ARF, CRF, toxic or ↑K…)
- If acidemic and underperfused think about the flow