EL PULMÓ I L'ALTA MUNTANYA.

Aclimatació a l'altitud.

Capacitat humana per gestionar l'Oxígen.

Diada Pneumològica 2015
Hospital Universitari de Bellvitge

Generalitat de Catalunya
Departament de Salut

Institut Català de la Salut
Gerència Territorial
Metropolitana Sud

Bellvitge
Hospital Universitari

American Medical Expedition to Mount Everest. 8.848 metres. 1981.

Dr. Chistopher Pizzo. Mostres d'aire alveolar.

Pulmonary gas exchange on the summit of Mount Everest.

J Appl Phisiol Respir Environ Exerc Physiol. 1983 Sep;55(3):678-87.
West JB et al.

Gasometria arterial a 8.848 metres

pH : 7,7

PCO_2 : 7,5 mmHg

PO_2 : 28 mmHg.

DEFINICIONS PER CONVENI INTERNACIONAL

Aclimatació:

Canvis fisiològics que permeten a un individu sobreviure en altitud.

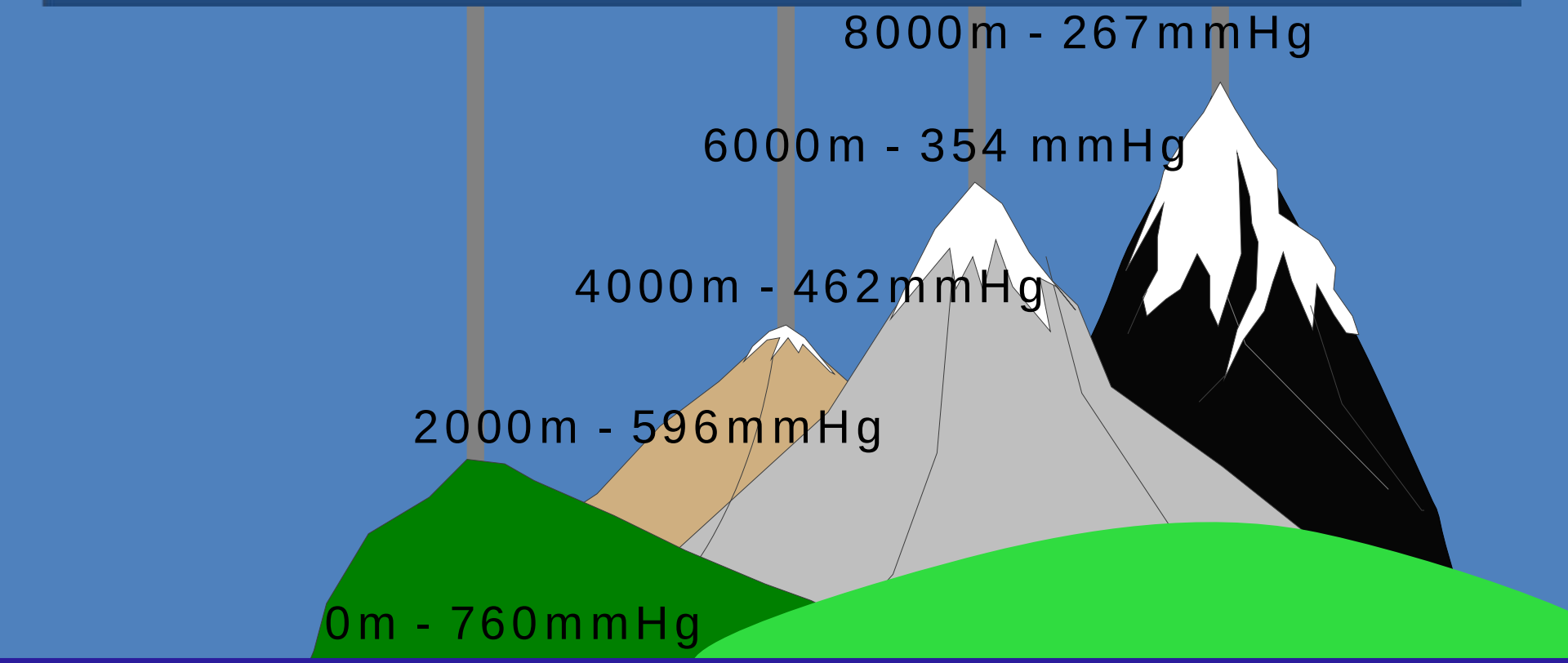
Son reversibles i no son transmisibles.

Adaptació:

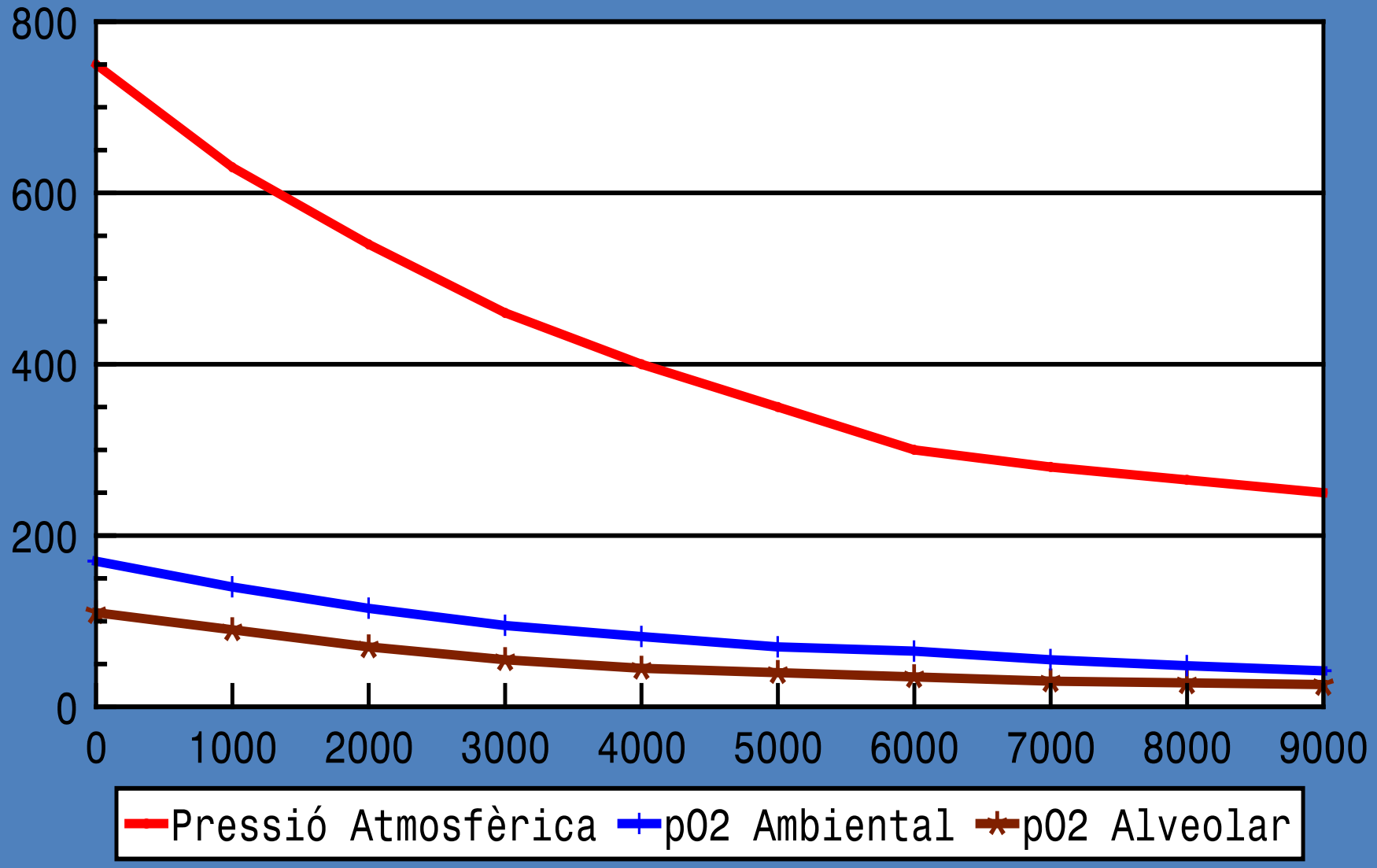
Canvis fisiològics que permeten a un grup sobreviure en altitud.

Son transmisibles i no son reversibles.

La pressió atmosfèrica és el pes de la columna d'aire que gravita sobre nosaltres



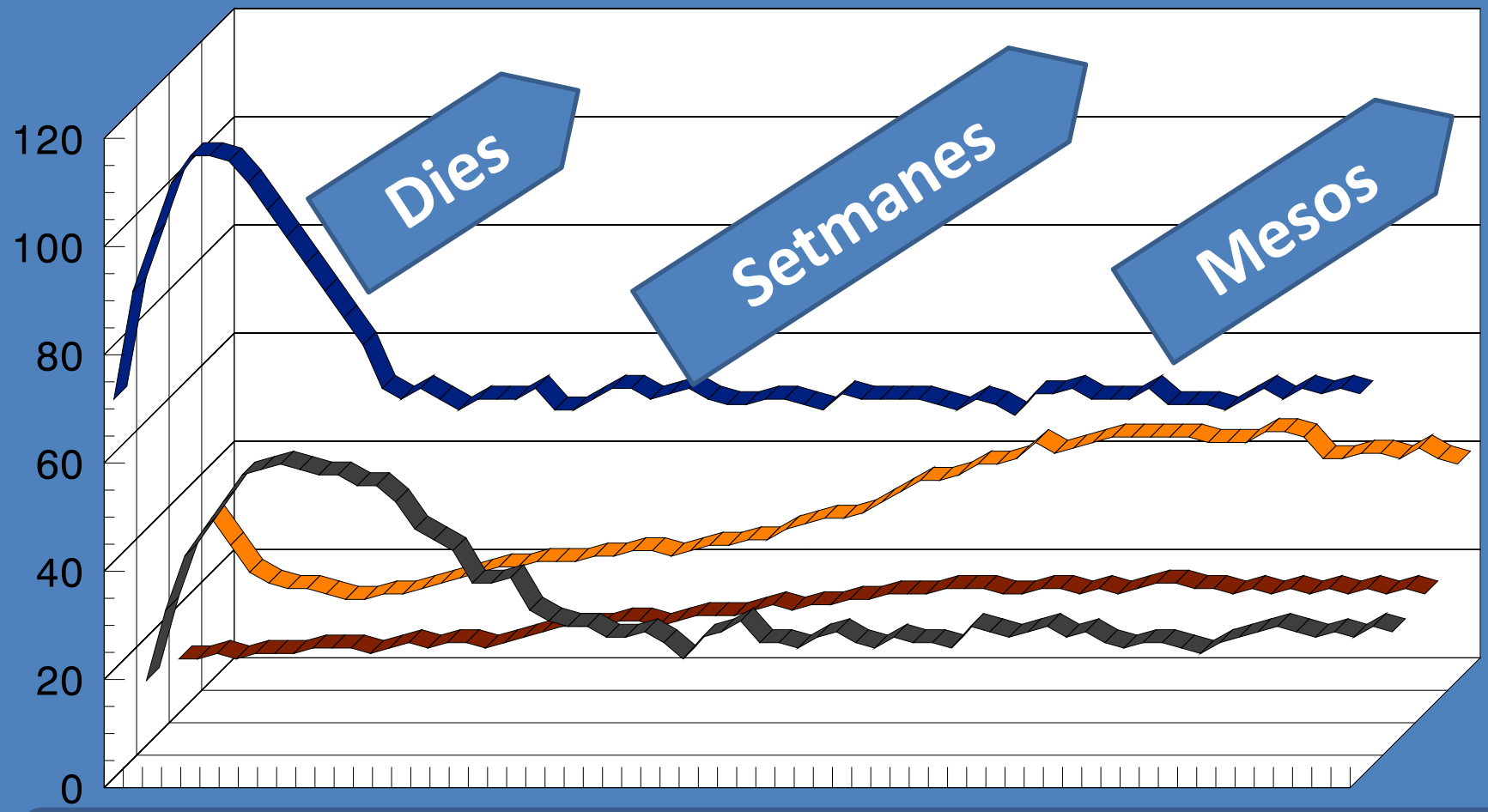
CORBA PRESSIÓ ATMOSFÈRICA



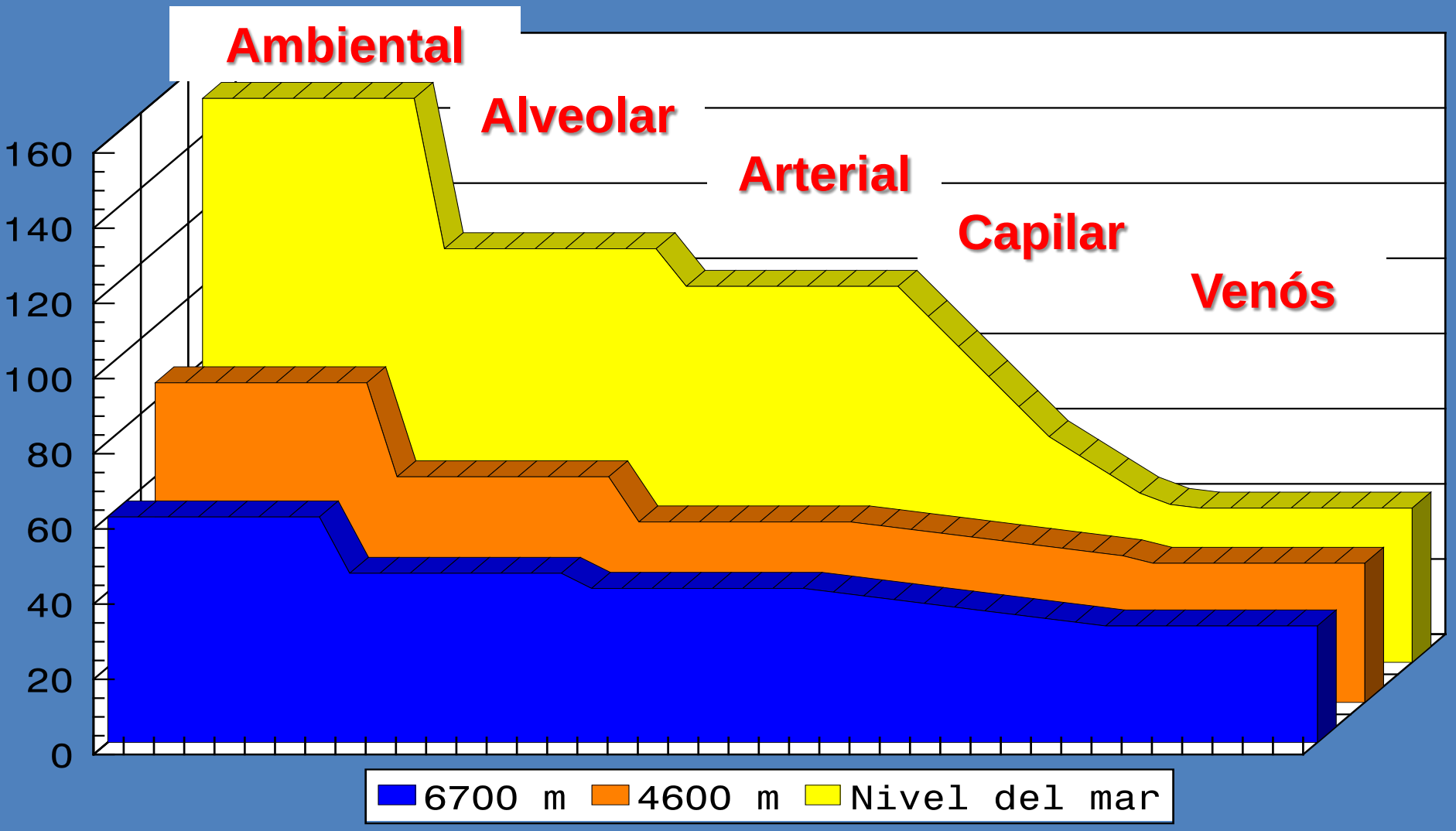
COMPOSICIÓ DE L'AIRE ALVEOLAR A DIFERENTS ALTITUDS.

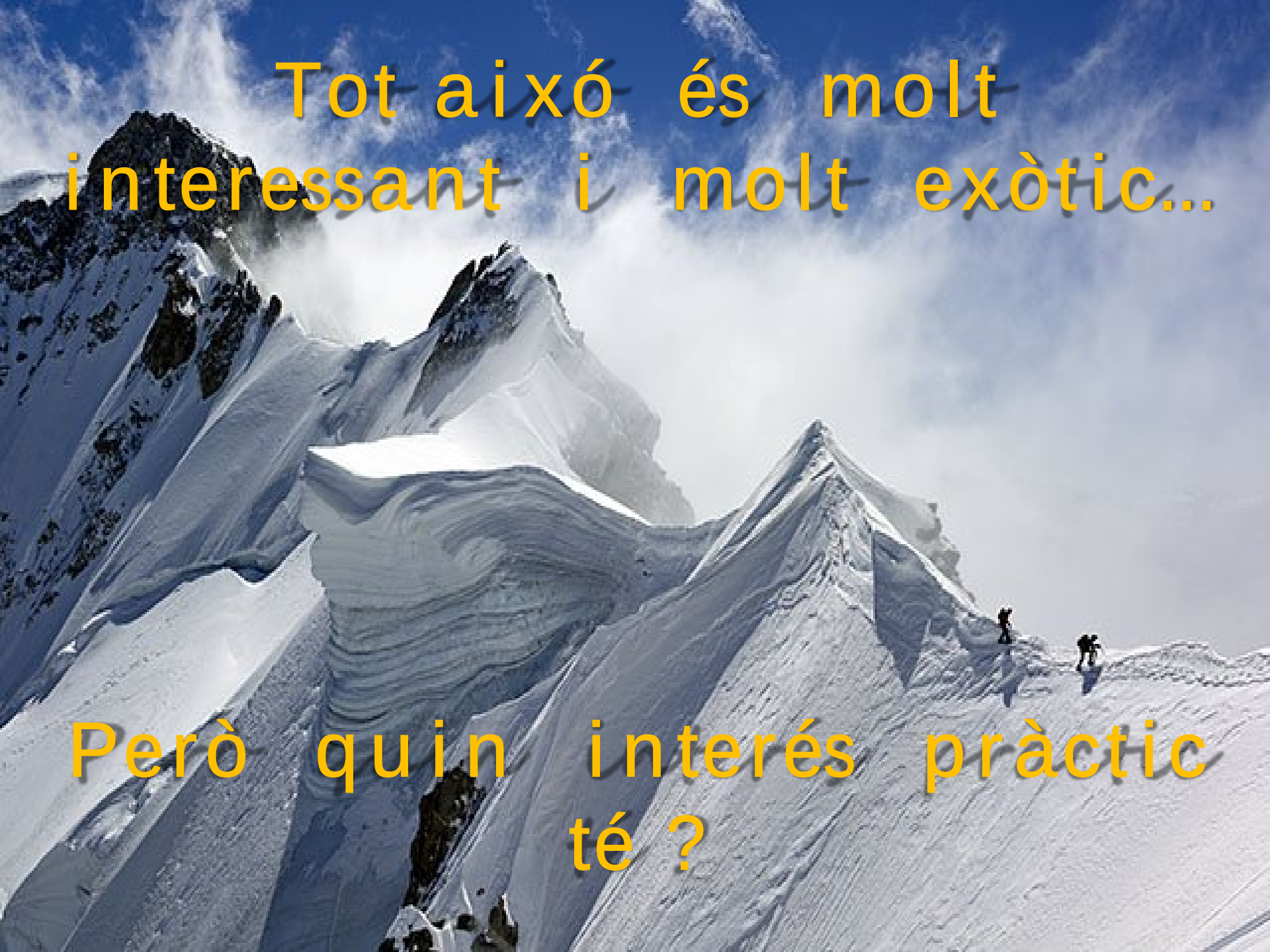
Altitud	Pressió ambiental	PO_2 ambiental	PO_2 alveolar	PCO_2 alveolar
Nivell mar	**750** mm Hg	**150** mm Hg	**110** mm Hg	**38** mm Hg
5.800 m	**380** mm Hg	**78** mm Hg	**51** mm Hg	**22** mm Hg
6.400 m	**344** mm Hg	**70** mm Hg	**40** mm Hg	**21** mm Hg
7.440 m	**300** mm Hg	**62** mm Hg	**37** mm Hg	**16** mm Hg
7.830 m	**288** mm Hg	**58** mm Hg	**36** mm Hg	**14** mm Hg
8.848 m	**253** mm Hg	**53** mm Hg	**34** mm Hg	**7,5** mm Hg

EVOLUCIÓ DELS MECANISMES D'ACLIMATACIÓ



Cascada d'Oxígen.




Tot això és molt interessant i molt exòtic...
Però quin interés pràctic té ?

Interés Fisiologia de la Hipòxia - 1

Medicina de l'esport i de l'exercici.

http://www.go2altitude.com/ GO2Altitude Hypoxicator fo...

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Welcome to GO2Altitude®

Recently discovered phenomenon of **Intermittent Hypoxic Training** (IHT) has been proven by practical experience and numerou scientific trials to be most efficient and practical simulated altitude training method for human and equine athletes.

Invented by us in 2005 new method of IHT with Hyperoxic recovery (also known as IHHT) additionally optimizes the training.

Short-term bursts of low and high oxygen air breathing doubles training efficiency. The response to mild hypoxia training stimuli almost instant triggering cascade of effects facilitated by HIF. Simply speaking, repetitive "signals" that are sent to the boc multiple times during the sessions are more beneficial than a single long-lasting one hypoxia exposure.

Top athletes worldwide use and praise GO2Altitude® hypoxicator for its efficacy and convenience in operation. Over the past 1 years we have received hundreds of great testimonials from our international customers (read more ...)

MasterClínic2015 | Diada-2015 [Modalit... | AltitudMalalties [M... | GO2Altitude Hypoxi... | CA | 21:18

Medicina de l'esport i de l'exercici.

Intermittent Hypoxic Training.

Medicina de l'esport i de l'exercici.

Intermittent Hypoxic Training.

Interés Fisiologia de la Hipòxia - 2

VIATGES EN AVIÓ.

Cabina entre 2.500 i 3.000 metres.

Interés de les companyies aèries en la seguretat.

Viatges en avió.

AMA commission on emergency medical services. Medical aspects of transportation aboard commercial aircraft. JAMA 247: 1007-1011 (1982).

British Thoracic Society recommendations Managing passengers with respiratory disease planning air travel. Thorax 57: 289-304 (2002).

MALALTIES RESPIRATÒRIES I VIATGES EN AVIÓ.

1. Es tolera PO_2 inferior a 50 mmHg durant hores sense símptomes.
2. PAP augmenta 20 – 30 mmHg (20 – 25%).
3. Descens de la PO_2 es relaciona més amb el grau d'obstrucció que amb l'altitud a la cabina.
4. PTH: aproximació del 70% per predir PO_2 inferior a 50 mmHg.
5. Les descompensacions de MPOC durant els viatges en avió són excepcionals.

Interés Fisiologia de la Hipòxia – 3.

Viatges pacients amb malaltia respiratòria.

Monestir de Rongbuk
5.200 m.

Vessant Nord Everest
8.848 m.

VIATGES I ESTADES EN ALTITUD.

INTERESSOS TURÍSTICS, LABORALS, ECONÒMICS, MILITARS O ESTRATÈGICS.

MALALTIA PULMONAR OBSTRUCTIVA CRÒNICA.
ASMA BRONQUIAL.

RESUM ESTUDIS SOBRE ESTADA EN ALTITUD AMB MALALTIES RESPIRATÒRIES - MPOC.

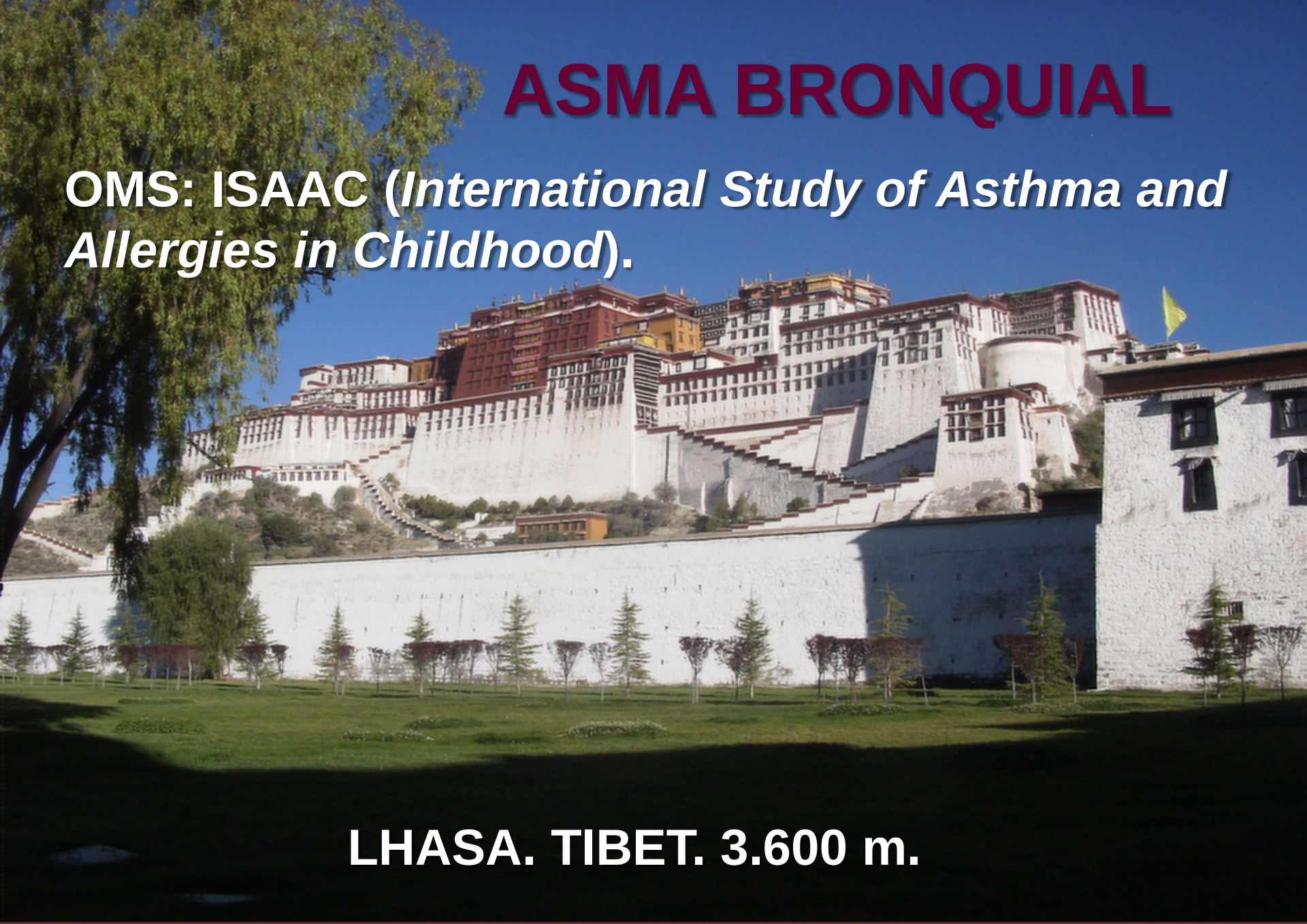
a) British Thoracic Society recomana permetre estada en altitud si PO_2 i VEF1 són estables.

b) Programes de rehabilitació en altitud (1500-2500 m) milloren capacitat exercici sense complicacions.

c) Fibrosi quística: les complicacions aparegudes van ser degudes a obstrucció bronquial, no a l'altitud - hipòxia.

ASMA BRONQUIAL

OMS: ISAAC (*International Study of Asthma and Allergies in Childhood*).



LHASA. TIBET. 3.600 m.

ESTUDIS ASMA I ALTITUD.

1. Exposició aguda a hipoxia pot produïr broncoespasme.

2. Els asmàtics milloren en altitud si l'estada és llarga. Paral·lelisme amb l'aclimatació.

3. Disminució de la reactividad bronquial sobre dels 3000 m. No relacionat amb al·lergens perqué amb aclimatació en cambra hipobàrica, sense canviar de residència, tenen mateix efecte.

4. Efecte antiinflamatori de l'aclimatació. Hipótesi: reducció de la concentració de radicals lliures d'oxígen i de l'estrés oxidatiu.

Interés Fisiologia de la Hipòxia 4.

Exposició intermitent a la hipòxia hipobàrica.

Recursos miners.
Interessos militars.

Aucanquilcha. 5.334 m. Xile.

Instalacions mineres més elevades amb població permanent. 5.770 m.

Capanna Regina Margherita.
Monte Rosa. 4.554 m.

Pyramid International Laboratory.
Lobuche, Khumbu Valley, Nepal.

Istituto Pio XII Misurina onLus

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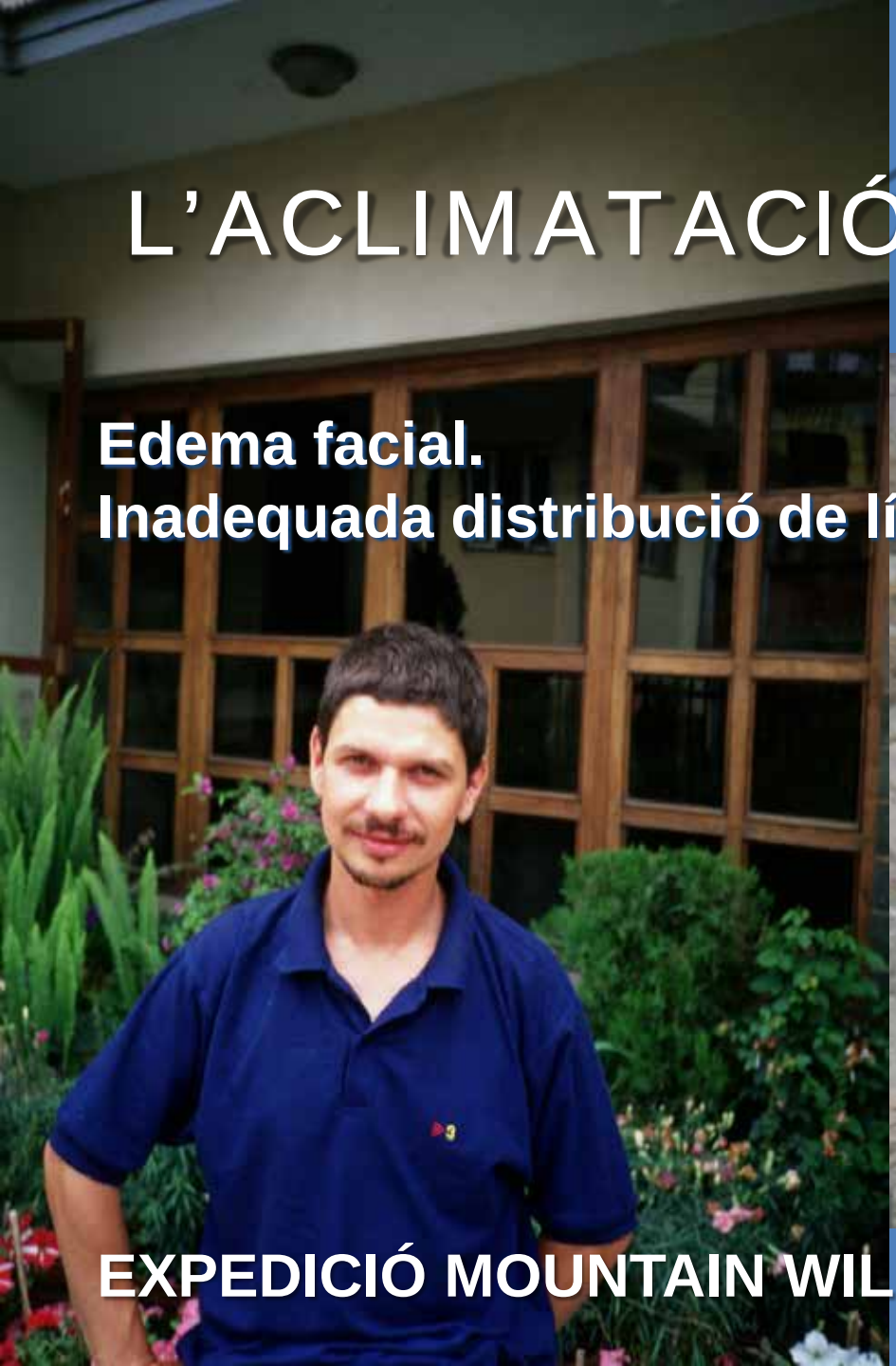
Centro di Diagnosi, Cura e Riabilitazione dell'Asma Infantile

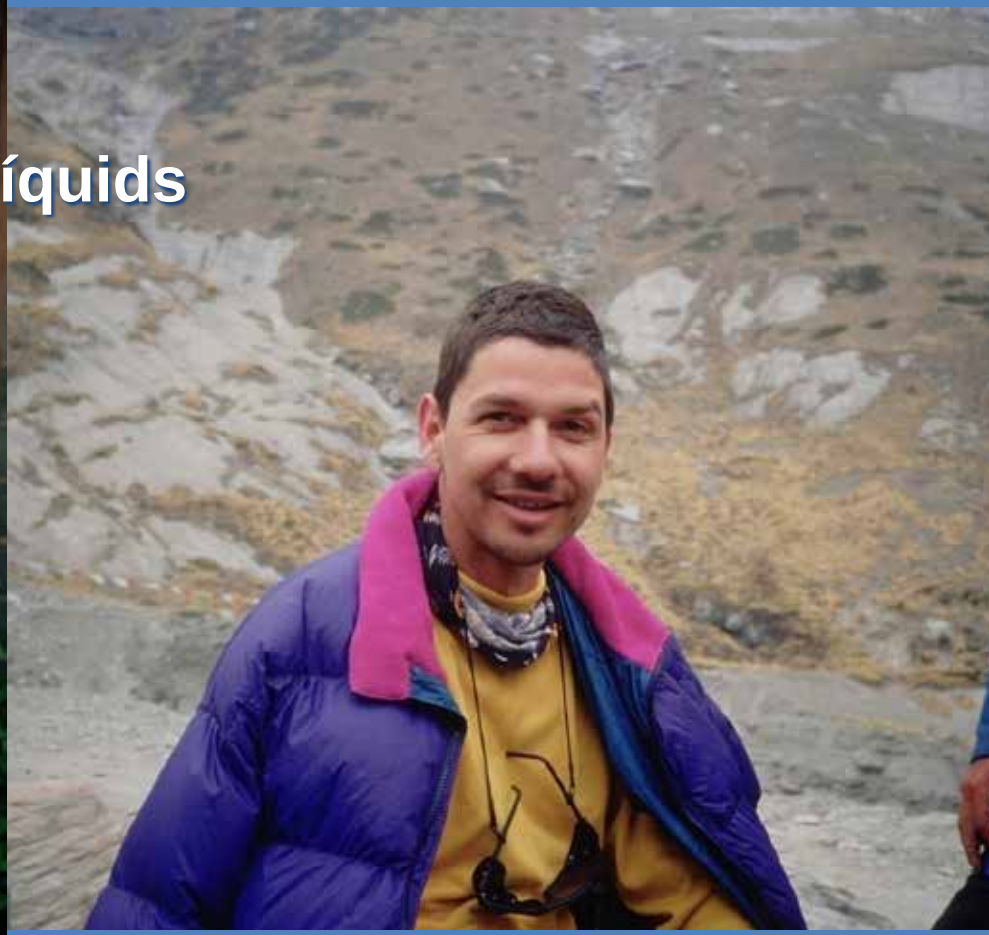
HOME

L'Istituto Pio XII sorge in Misurina di Auronzo, a 1756 metri sul livello del mare ed occupa l'antica e bellissima sede del Gran Hotel Savoy, residenza estiva dei reali d'Italia.

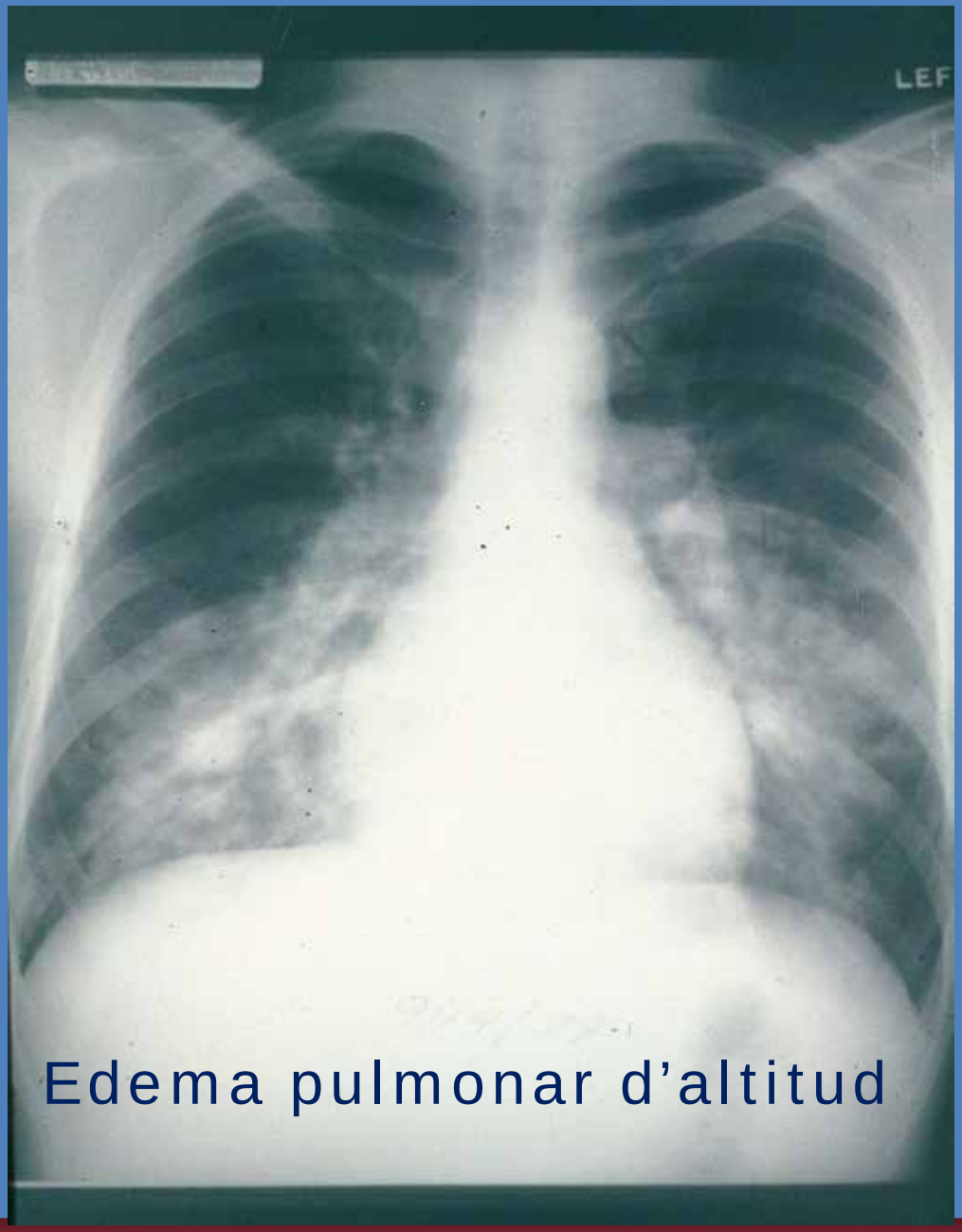
L'ACLIMATACIÓ SURT GRATIS ?

Edema facial.
Inadequada distribució de líquids

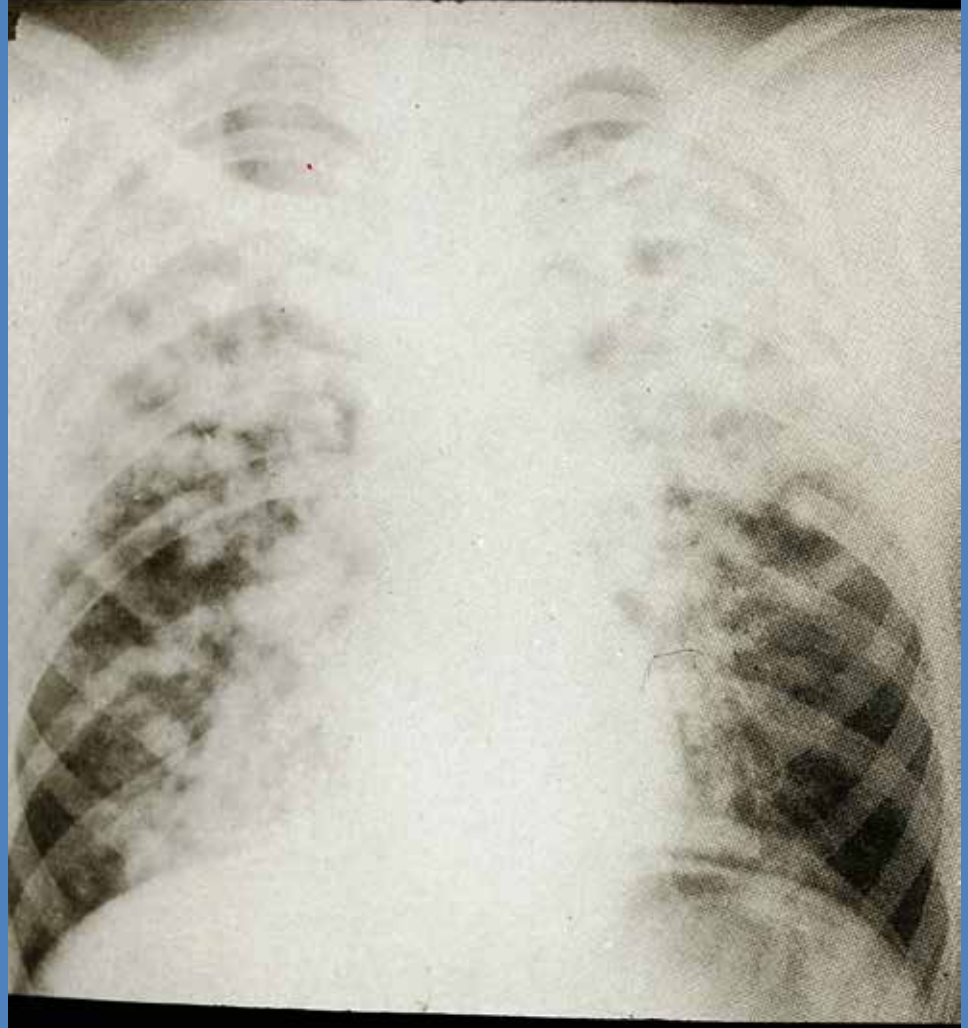




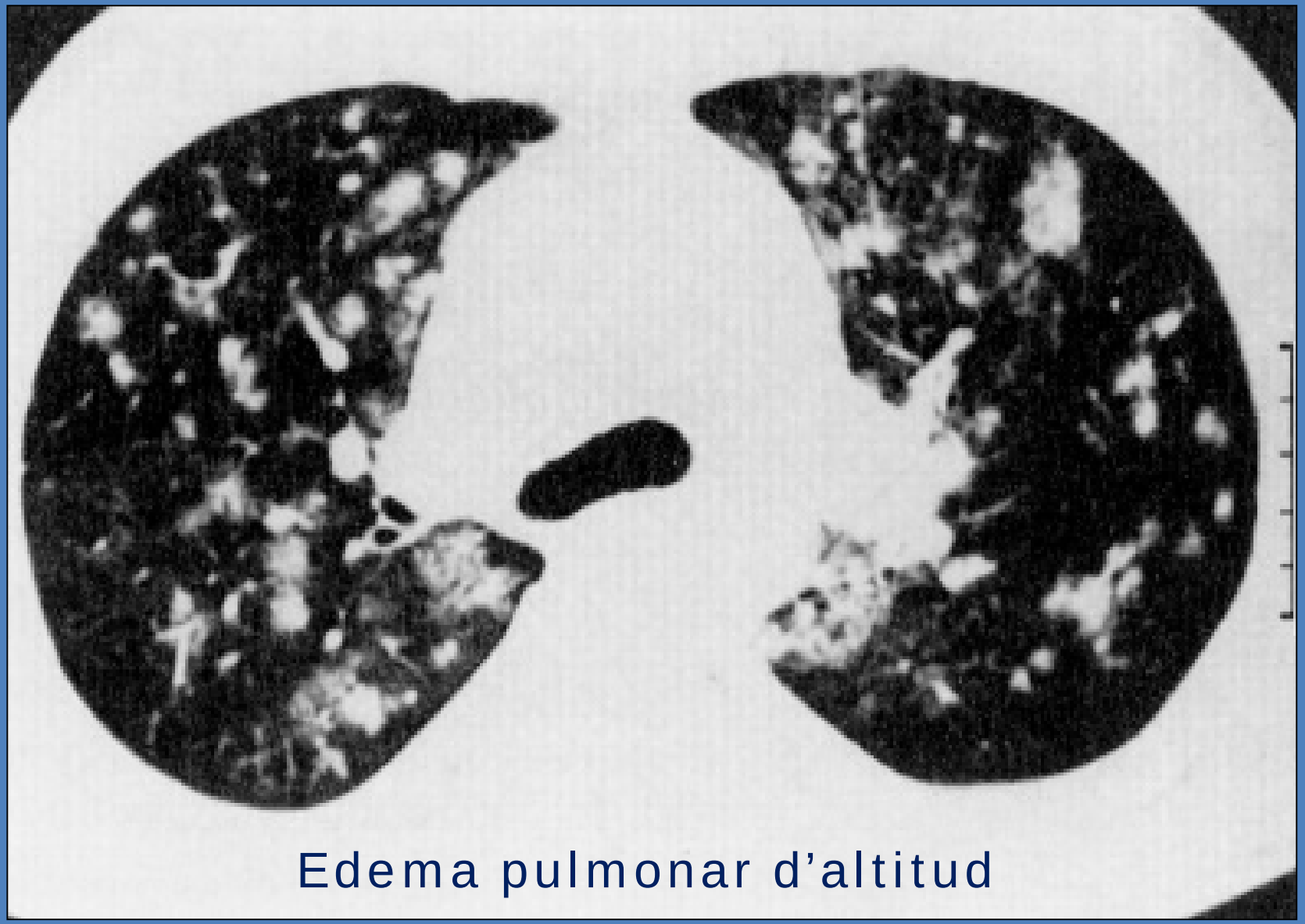
EXPEDICIÓ MOUNTAIN WILDERNESS. ANNAPURNA 1.999



Edema pulmonar d'altitud

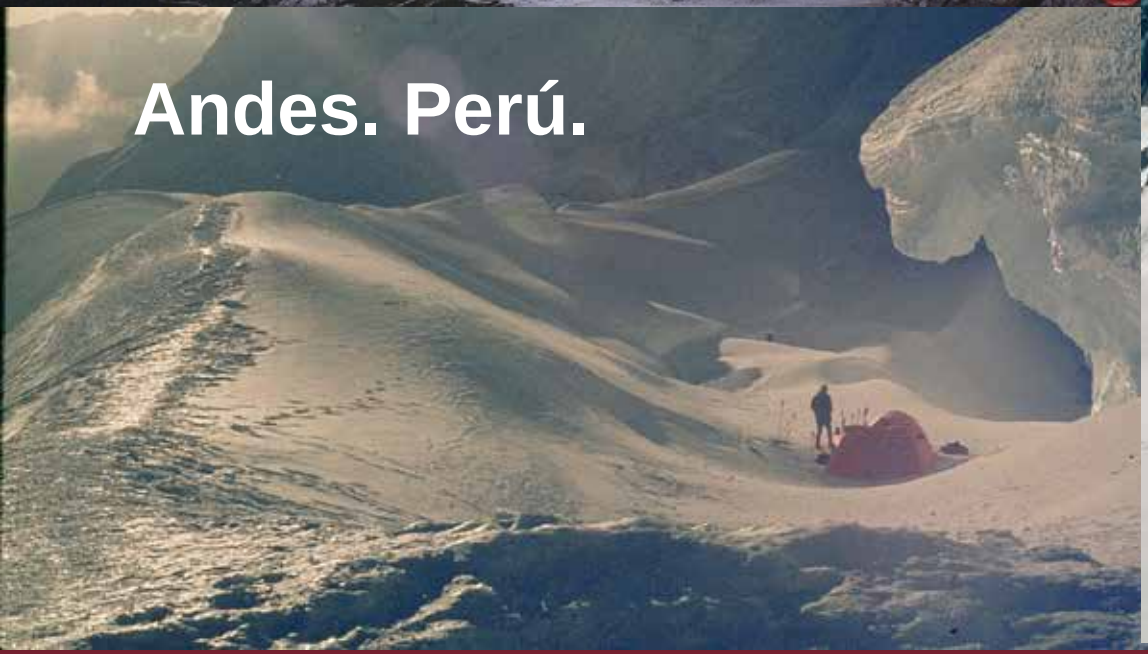


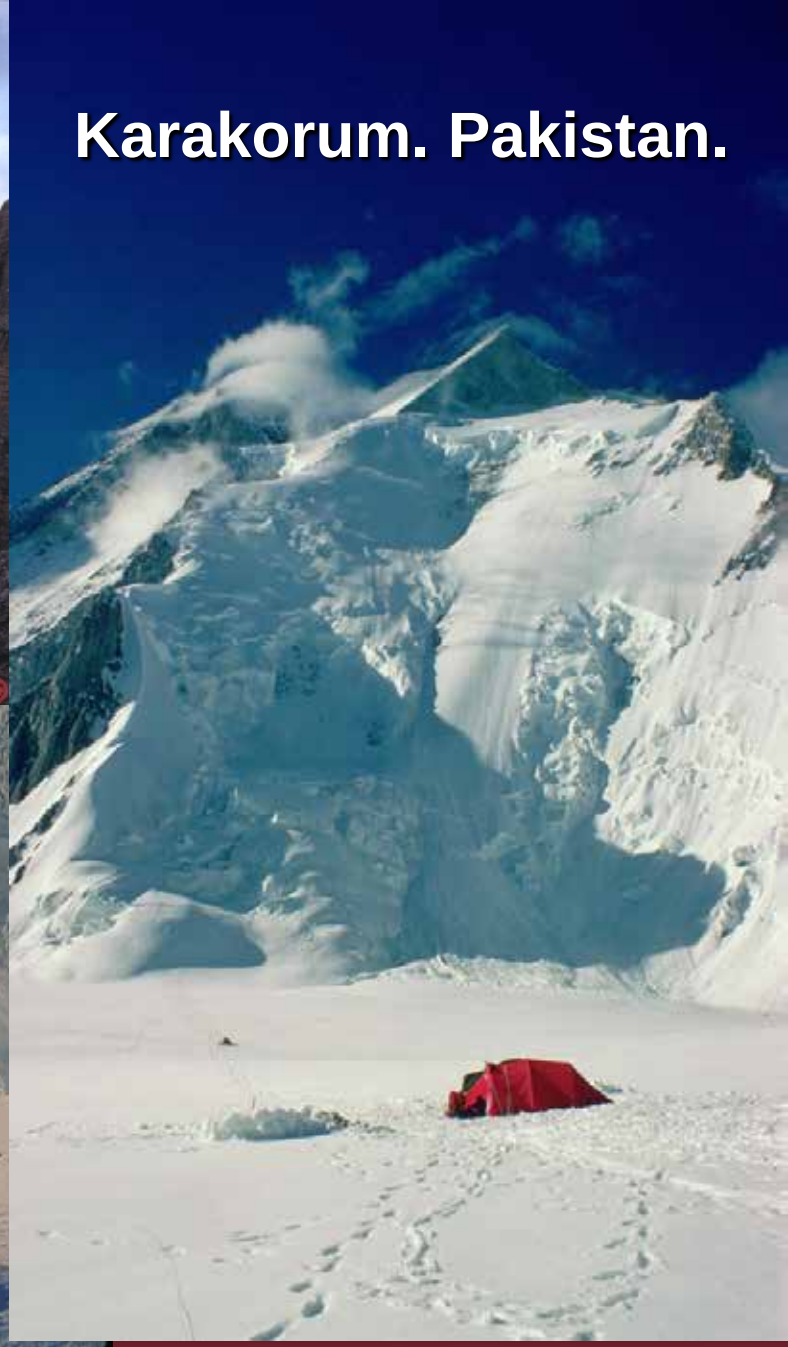
Edema pulmonar d’altitud

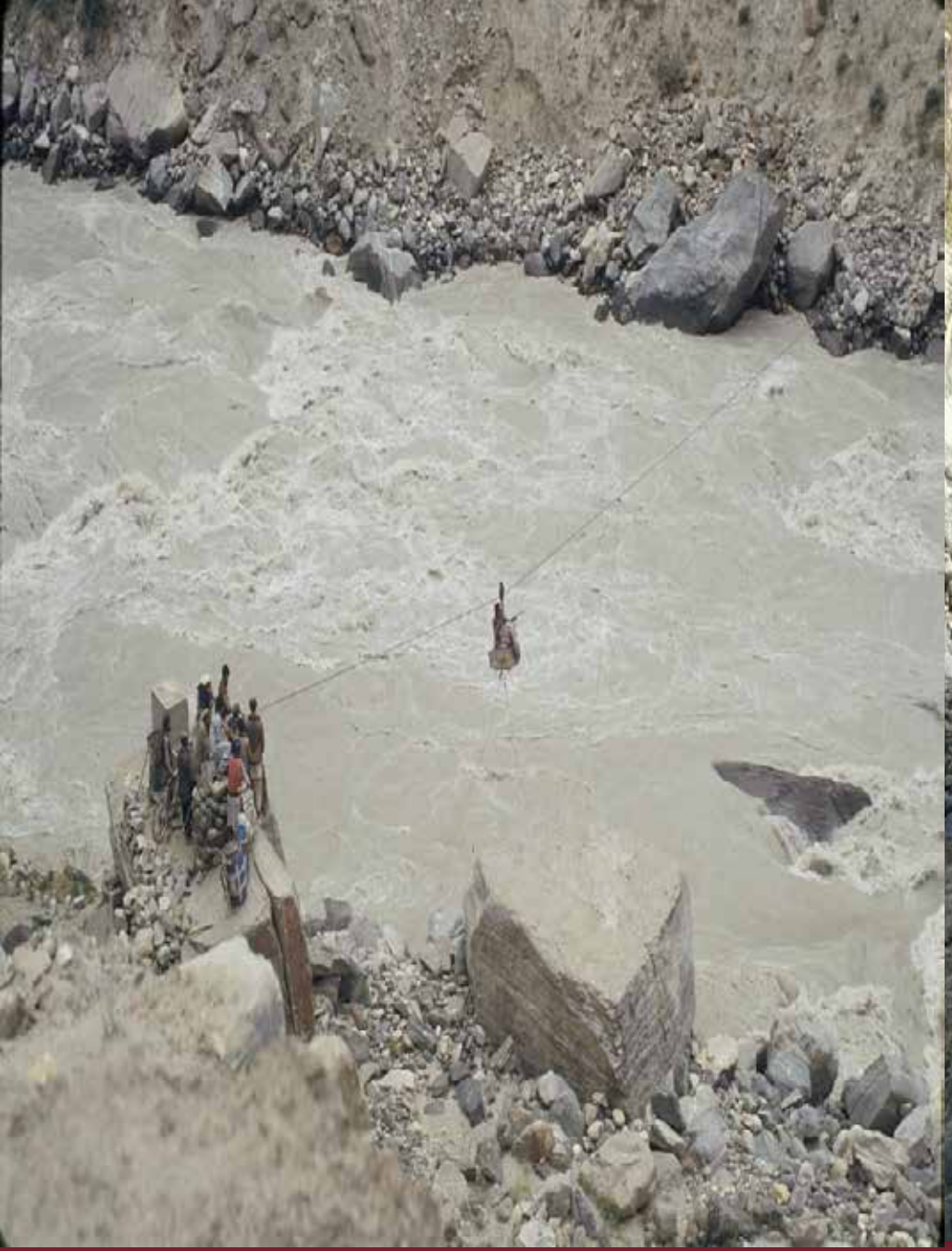


Edema pulmonar d’altitud


Alps. Italia


Andes. Perú.


Karakorum. Pakistan.



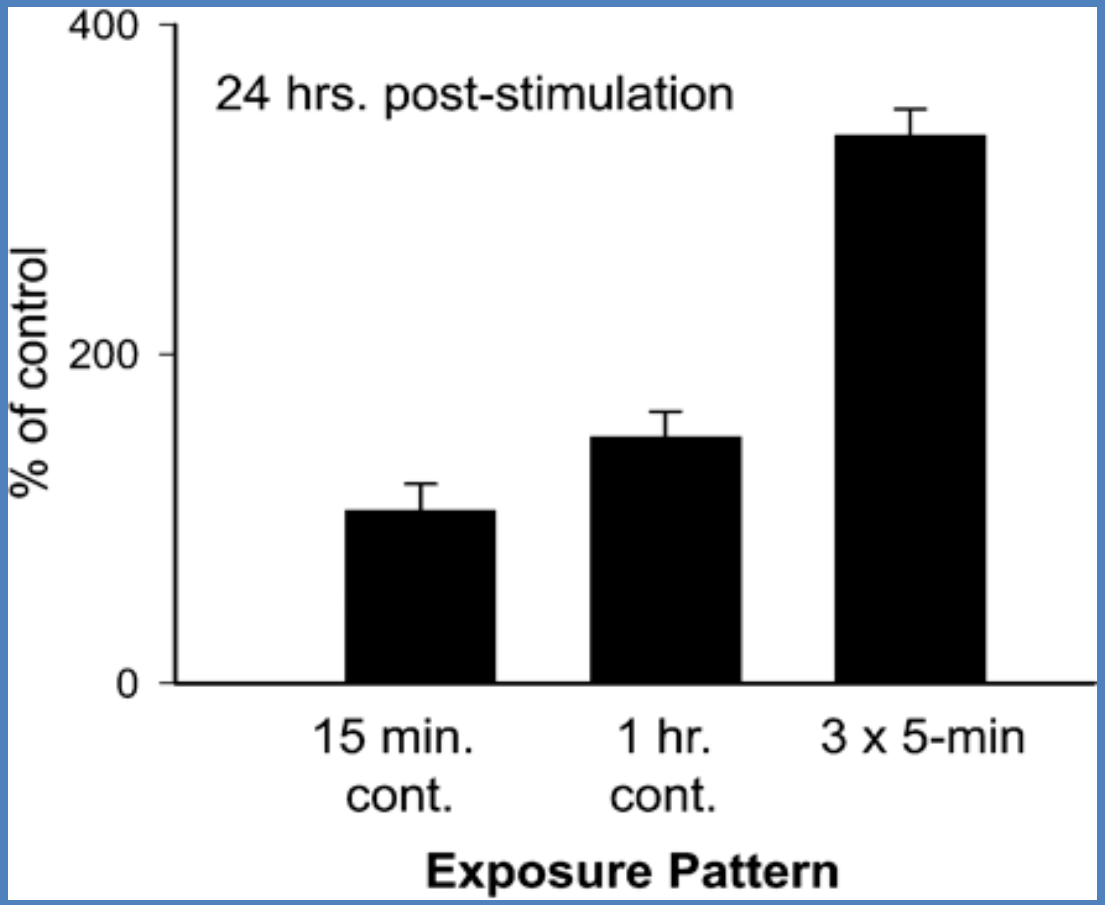

KUNDE HOSPITAL

Masherbrum 7.821 m Karakorum Pakistan

Invited Review: Intermittent hypoxia and respiratory plasticity.

Gordon S. Mitchell , Tracy L. Baker , Steven A. Nanda , David D. Fuller , Andrea G. Zabka , Brad A. Hodgeman , Ryan W. Bavis , Kenneth J. Mack , E. B. Olson Jr.

Journal of Applied Physiology.
Published 1 June 2001 Vol. 90no. 6, 2466-2475DOI:



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3. **Chronic Intermittent Hypoxia at High Altitude Exposure for over 12 Years: Assessment of Hematological, Cardiovascular, and Renal Effects.** Julio Brito et al. High Altitude Medicine & Biology. Aug 2007, Vol. 8, No. 3: 236-244
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6. **Resting arterial oxygen saturation and breathing frequency as predictors for acute mountain sickness development: A prospective cohort study.** M. Faulhaber et al. Sleep and Breathing. Sep 2014, Vol. 18: 669-674
7. **Reduced Incidence and Severity of Acute Mountain Sickness in Qinghai–Tibet Railroad Construction Workers after Repeated 7-Month Exposures despite 5-Month Low Altitude Periods.** Tian Yi Wu et al. High Altitude Medicine & Biology. Sep 2009, Vol. 10, No. 3: 221-232
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9. **Effects of Intermittent Exposure to High Altitude on Pulmonary Hemodynamics: A Prospective Study.** Akpay S. Sarybaev et al. High Altitude Medicine & Biology. Dec 2003, Vol. 4, No. 4: 455-463

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Estudios con enfermos EPOC en avión:

1. Se tolera PO2 < 50 mmHg durante horas sin síntomas.
2. HTAP aumenta entre 20 y 30 mmHg (20 - 25%).
3. Descenso PO_2 relacionado mas con obstrucción que con altura en la cabina.
4. PTH: aproximación 70% (para PO_2 < 50 mmHg).
5. Las descompensaciones de EPOC en los viajes aéreos son excepcionales.

Fórmula predicción PaO_2 a 2.500 m. de altura según Volumen Espiratorio Forzado 1 segundo.

PaO_2 altura = (0,453 · PaO_2 basal) + (0,386 · VEF1) + 2,44

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Consejos de la ISMM:

1. Viajar solo si PO_2 y VEF1 son estables.
2. PTH puede tener cierta utilidad como previsión de PO_2 en exposición aguda.
3. Tratamiento de base sin cambios. Organizar logística para que no pueda faltar en ambiente hostil y remoto.
4. Área remota? Médico experto bien equipado. Logística.
5. Cambios de altura lentos. A pié; no cambiar de altura por medios mecánicos.
6. Tiempo aclimatación largo.
7. Protección humo, polvo, frío, viento.
8. Premedicación en ejercicio y exposiciones agudas.

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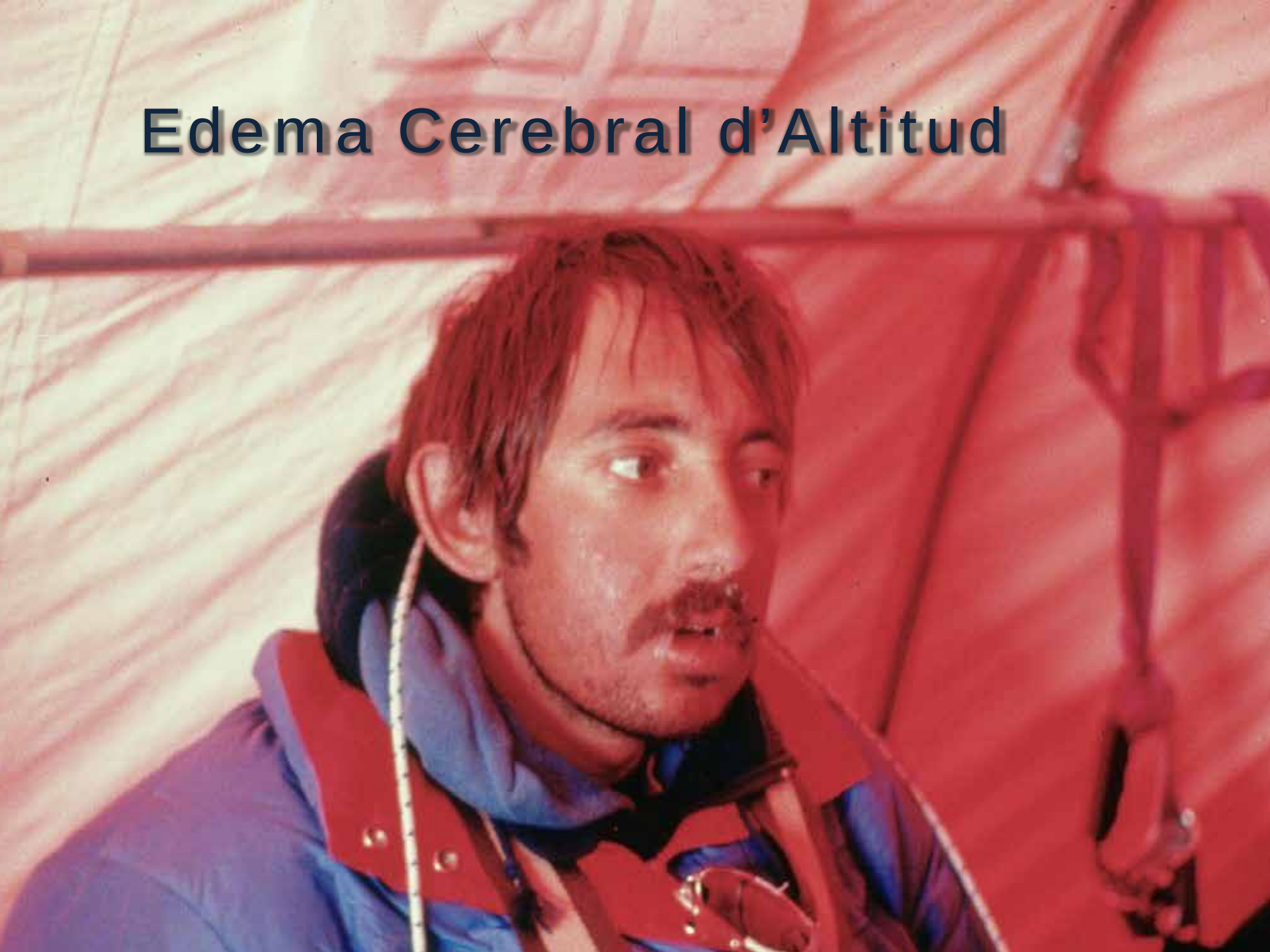
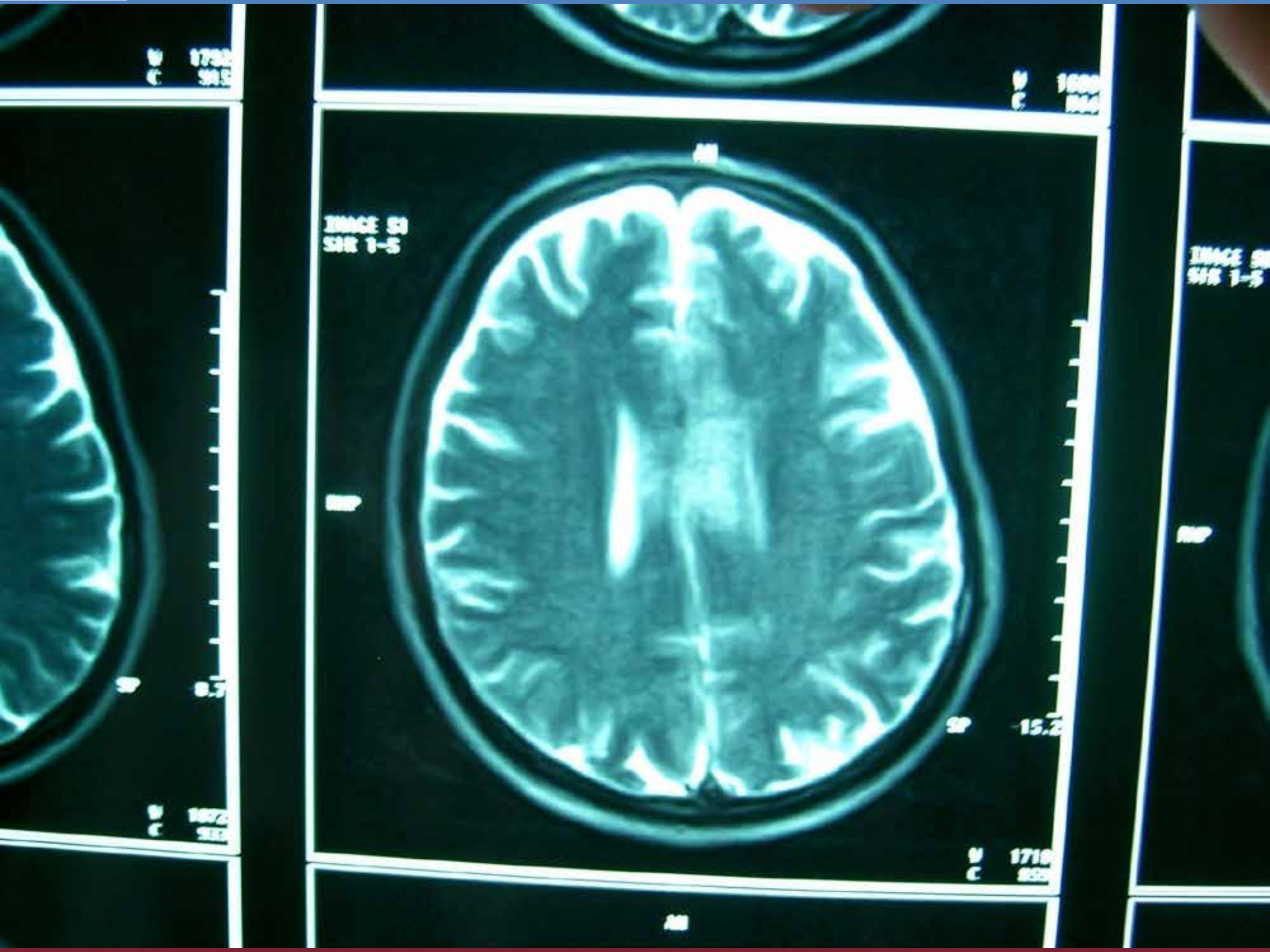
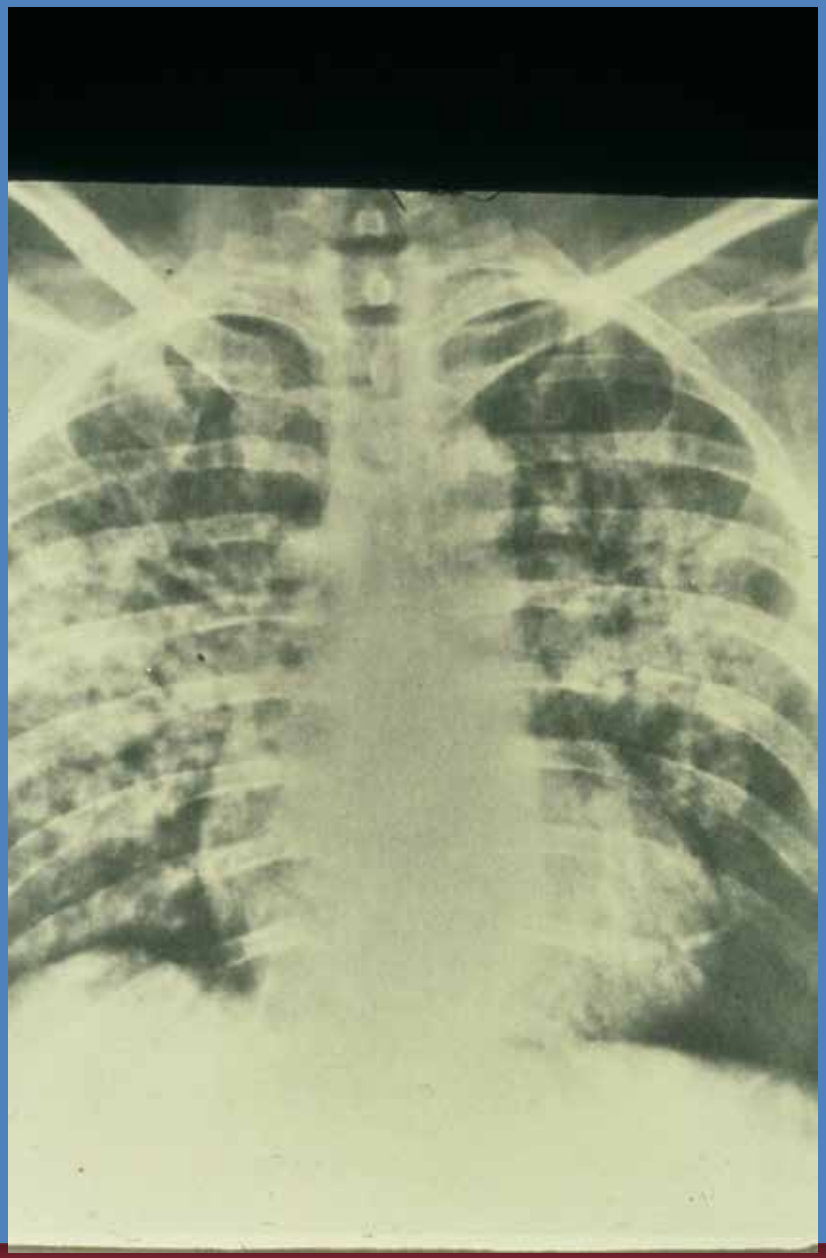
ADAPTACIÓ HUMANA A LA HIPÒXIA.

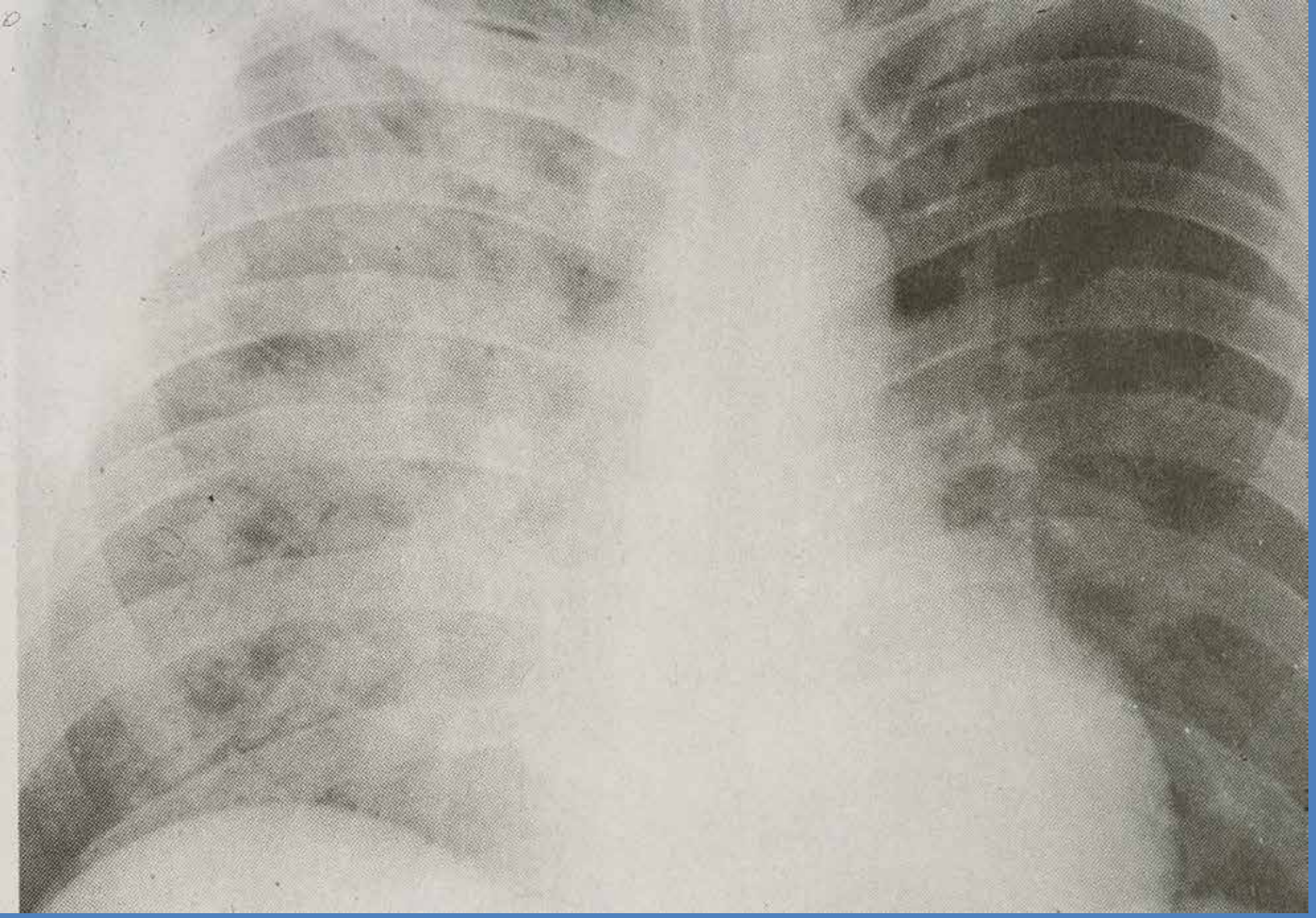
Capacitat humana per gestionar l'Oxígen.

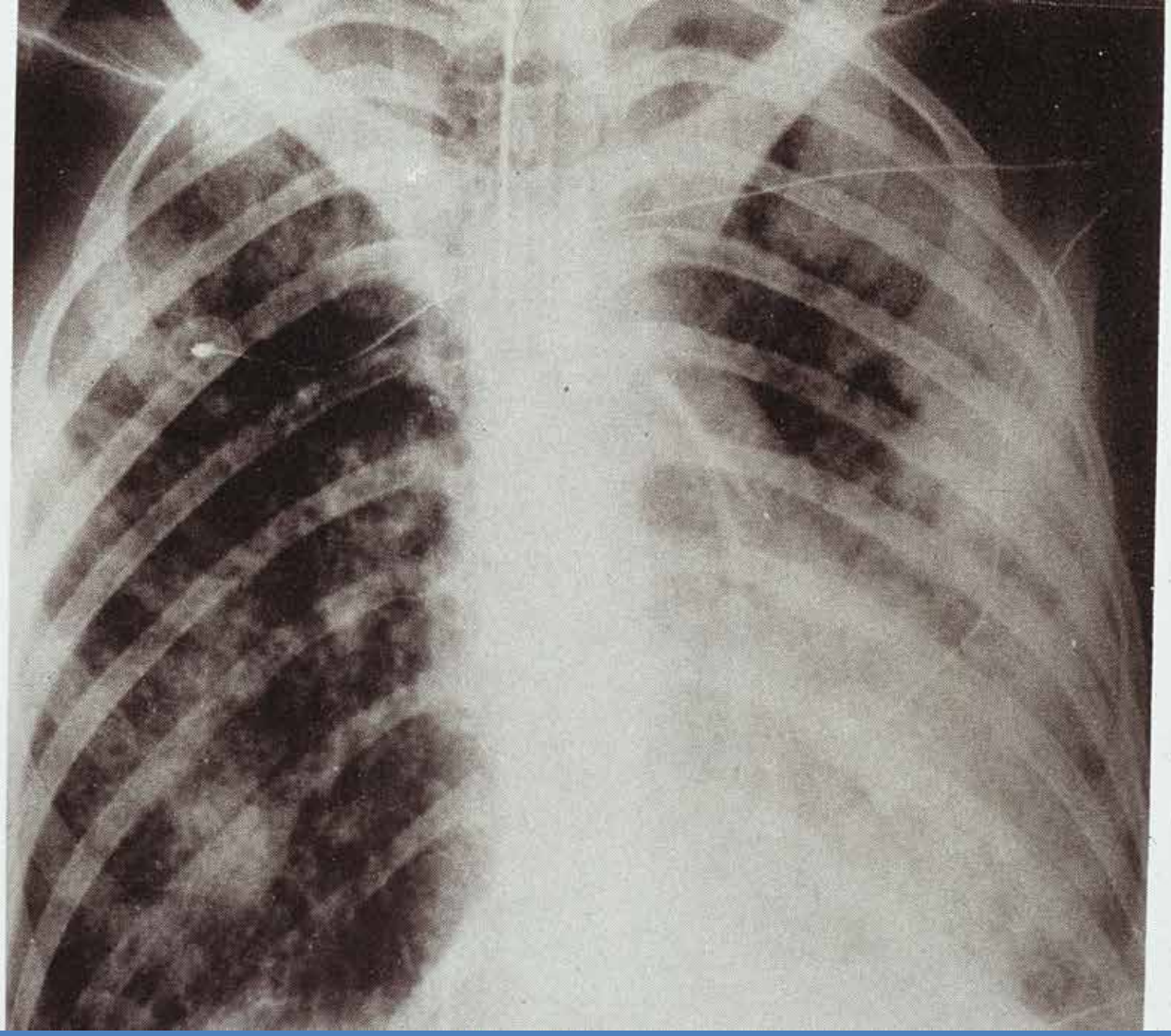
Edema Cerebral d'Altitud

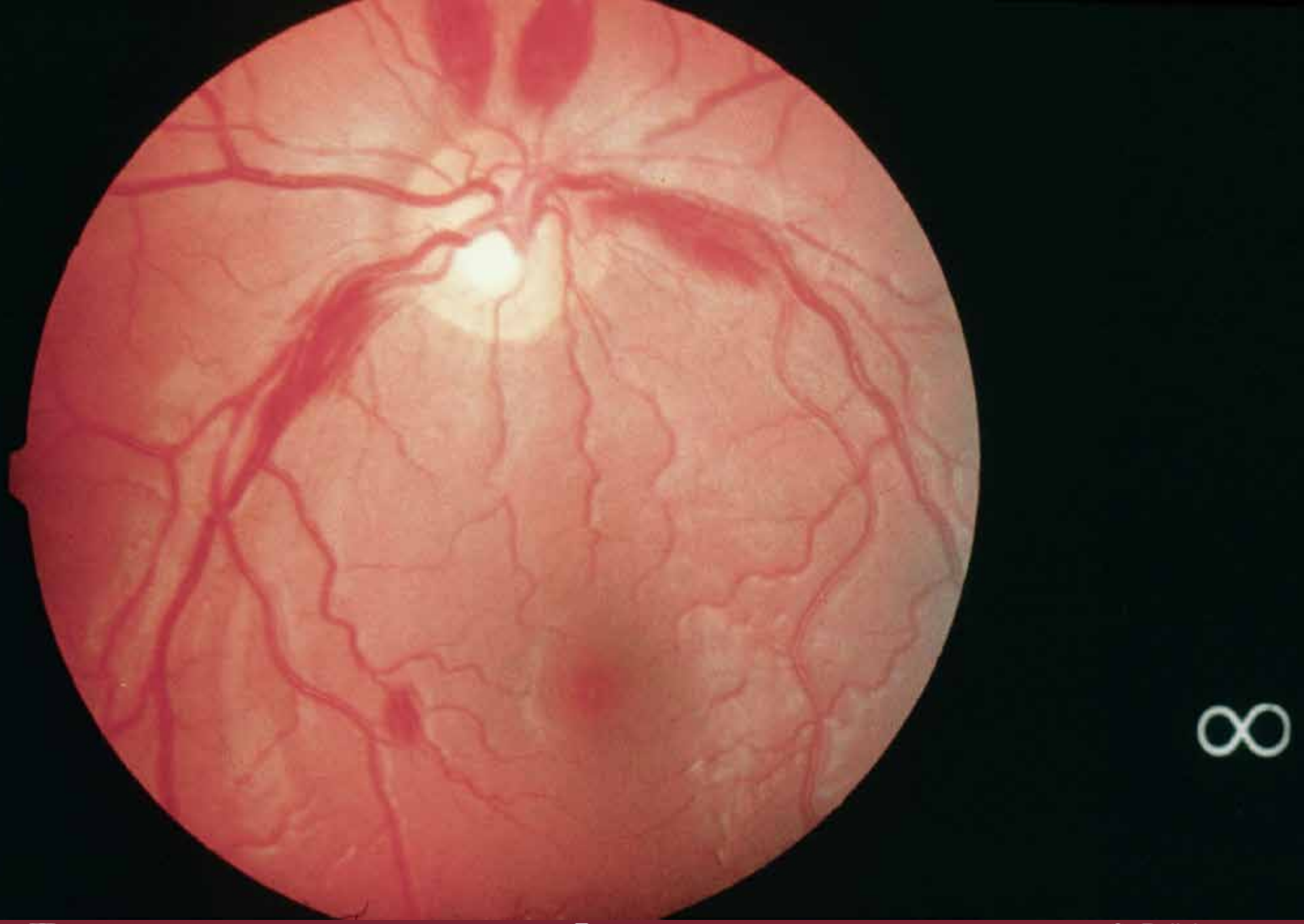


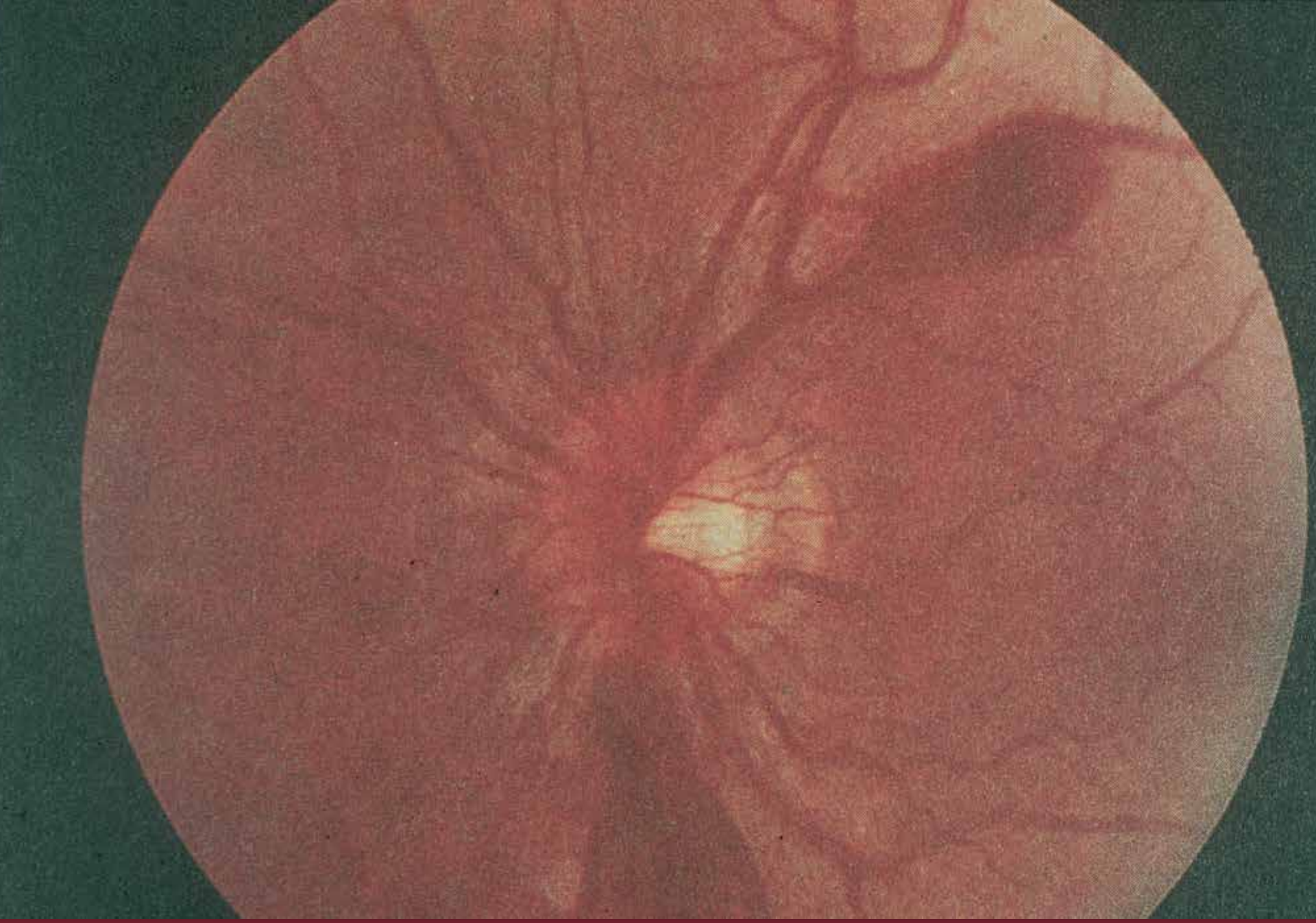












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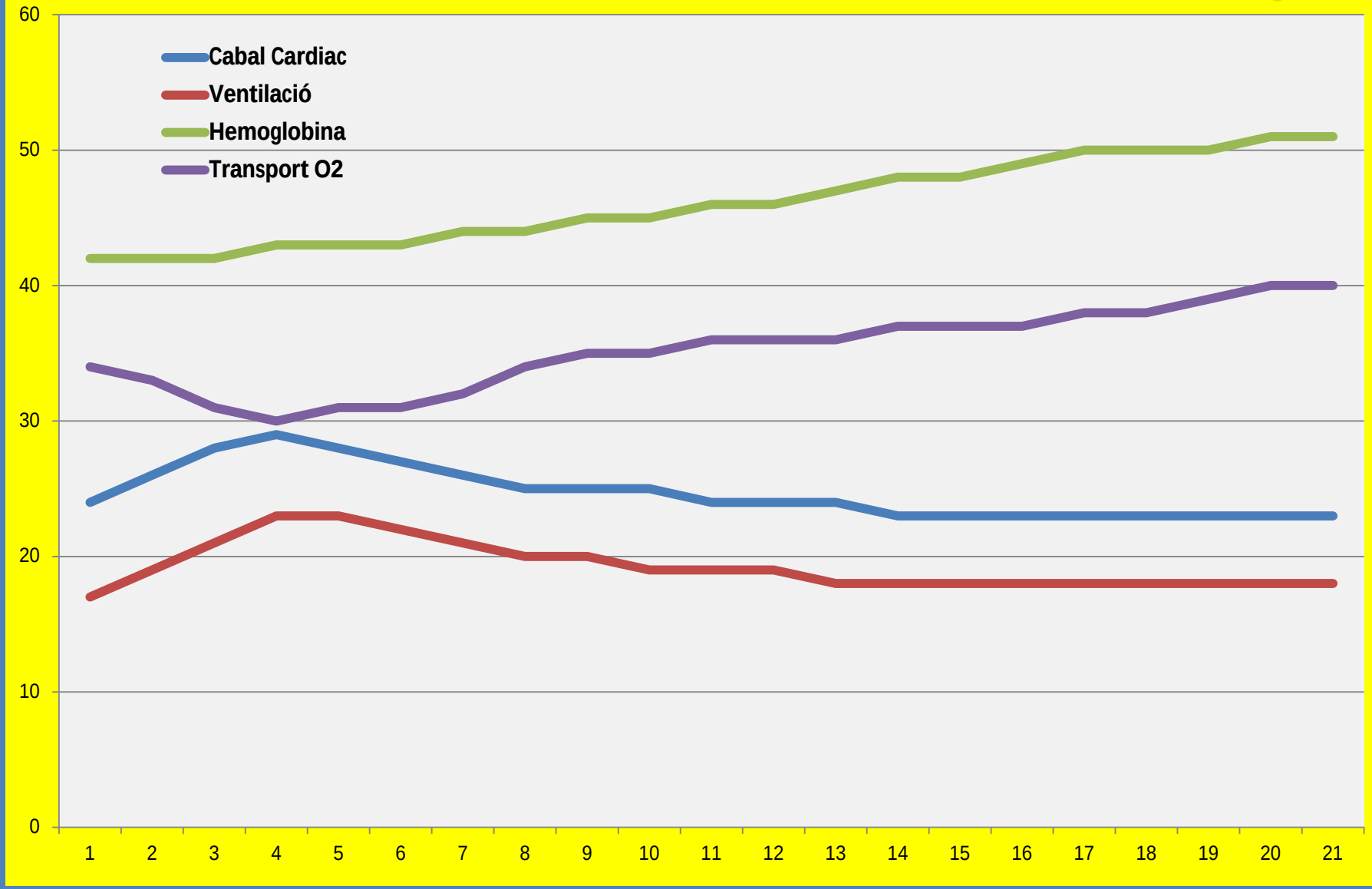
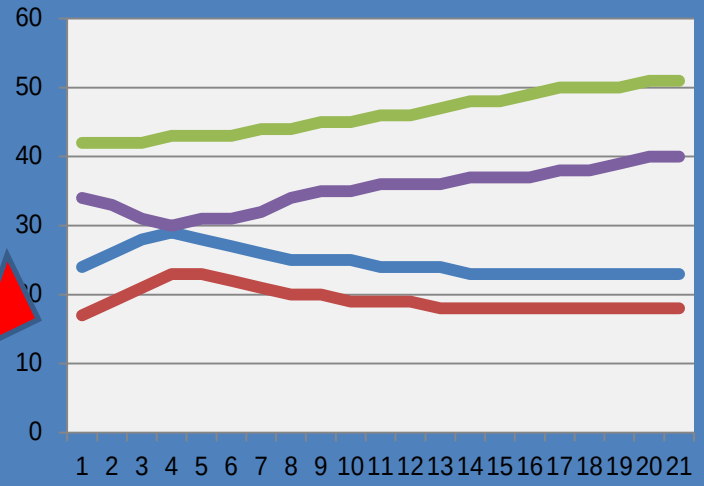
Els mecanismes de l'aclimatació en el temps



MECANISMES PULMONARS



1.- Fase aguda.

Hiperventilació.

Vasoconstricció arterial pulmonar.

2.- Fase crònica.

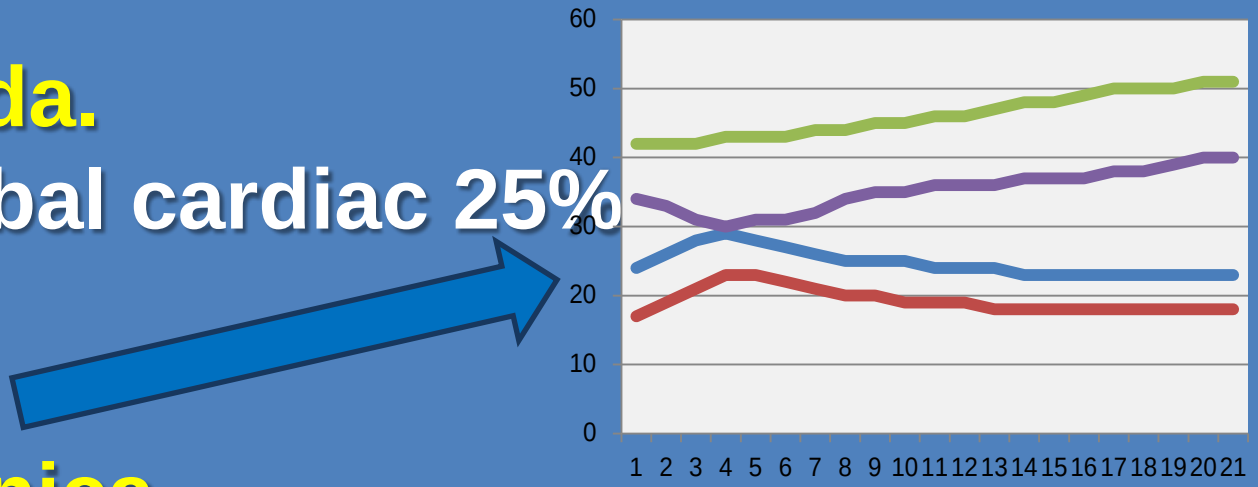
Augment capilarització pulmonar.

Vasoconstricció arterial pulmonar persistent?

MECANISMES CARDIOVASCULARS

1.-Fase Aguda.

Augment cabal cardiac 25%

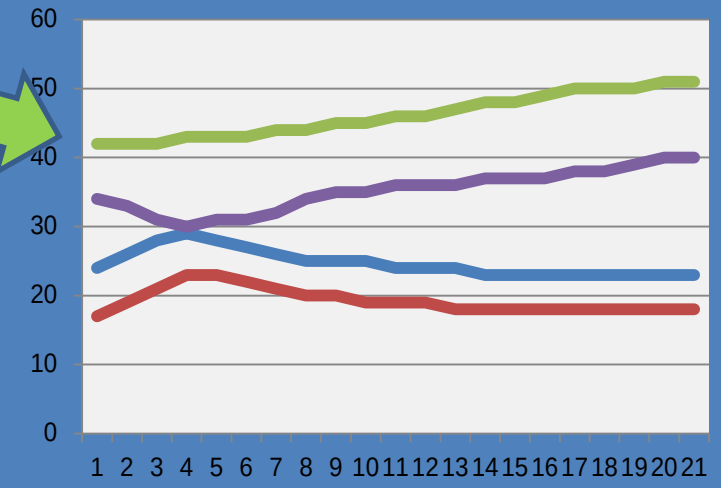


2.- Fase Crònica.

Disminució cabal cardiac 10% inferior a NM.

Aument capilarització perifèrica, cardiaca i pulmonar.

MECANISMES HEMATOLÒGICS



1.- Fase Aguda.

Augment eritropoietina.

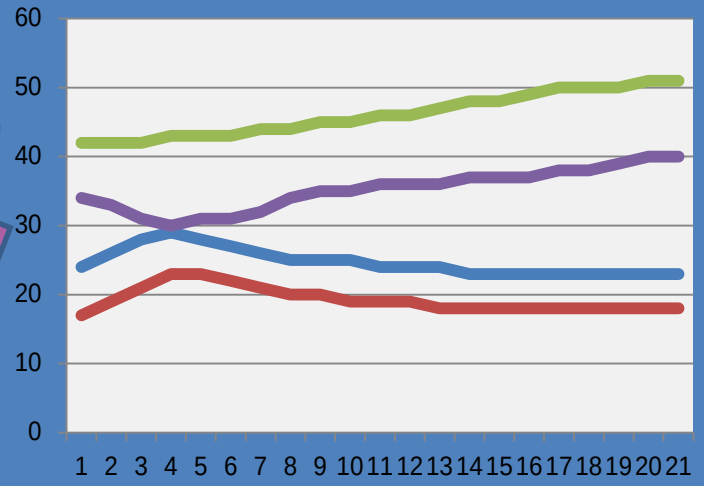
Augment afinitat Hb/O_2.

2.- Fase Crònica.

Augment massa eritrocitària – hemoglobina.

Disminució afinitat Hb/O_2.

MECANISMES CEL·LULARS i METABÒLICS



1.- Fase Aguda.

Hipòxia cel·lular.
Disfunció multiorgànica.

2.- Fase Crònica.

Canvis membrana cel·lular. Transport actiu
O_2 – Mioglobina
Augment nº mitocòndries