Scuba Diving Black out

Ali Bidari M.D.

President, Iran Society of Emergency Medicine

Shallow water blackout

- A 22-y-old athletic girl was found motionless inside a swimming pool by the witnesses
- She was immediately pulled out and found breathless with bluish lips and frothy mouth
- Basic life support measures were started until EMS took over the CPR
- He was transferred to hospital where after a prolonged CPR attempt announced to be dead
- A friend later said the victim was exercising breath hold diving to be employed in navy

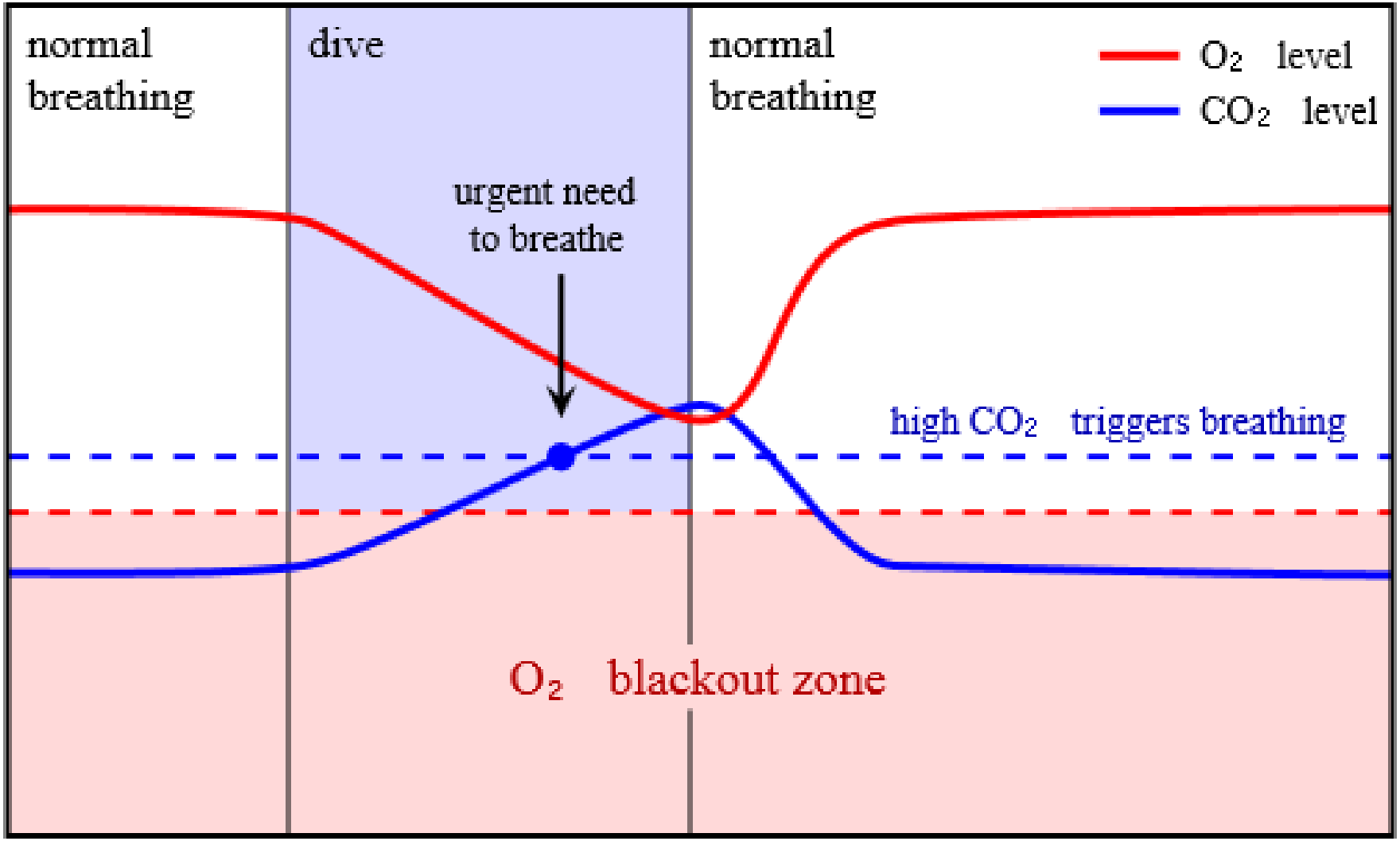
Shallow water blackout

- A loss of consciousness caused by cerebral hypoxia towards the end of a breath-hold dive in water
- Occurs at depth less than 5 meters
- No prior medical disabilities
- Victims do not necessarily experience an urgent need to breathe and has no other obvious medical condition
- Caused by hyperventilating, just before a dive
- Victims are often established practitioners of breath-hold diving, are fit, strong swimmers, and have not experienced problems before

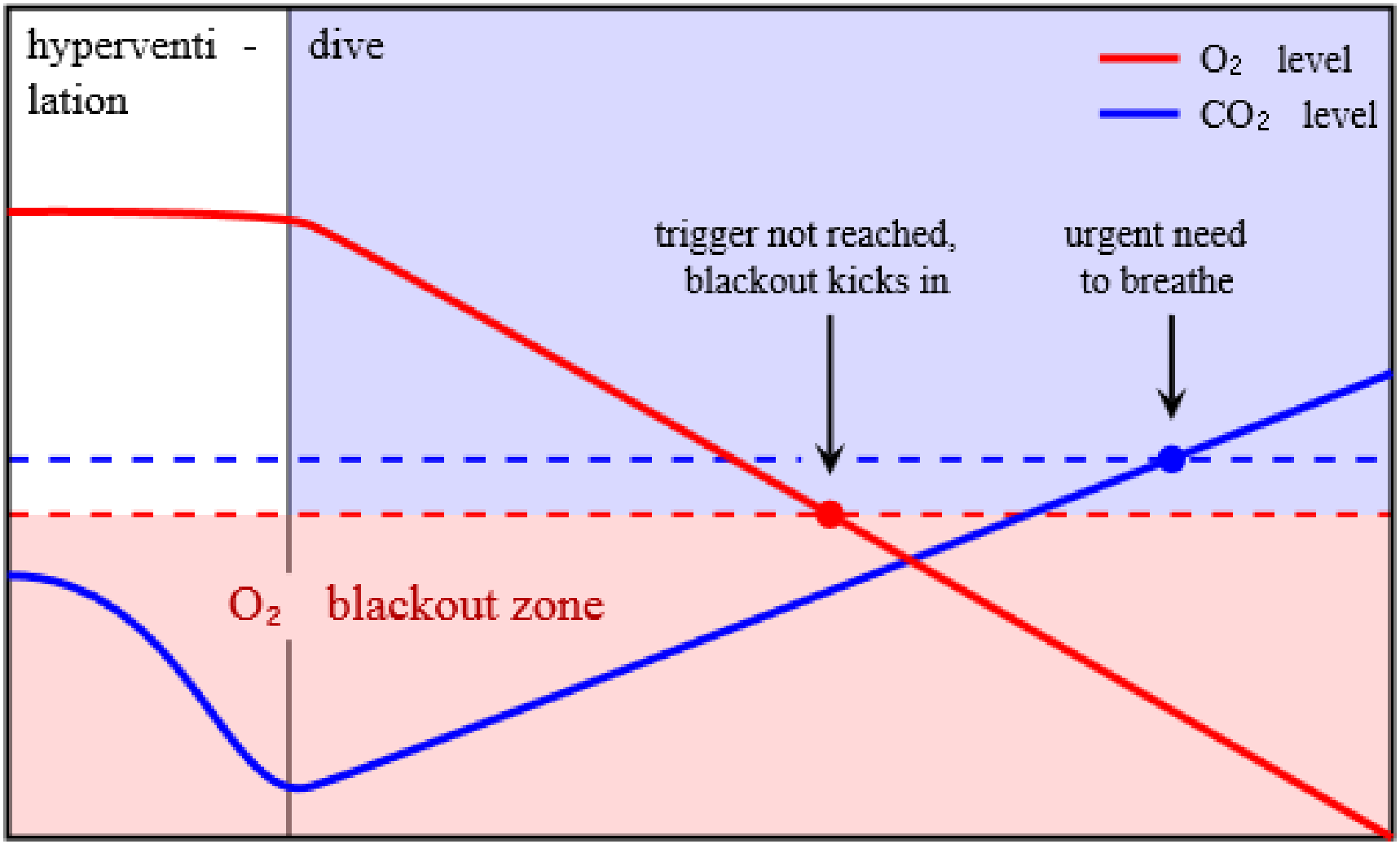
Hyperventilation and then a breath-hold diving

	0 sec	30 sec	60 sec	90 sec	120 sec	150 sec	180 sec
paO2	110	90	70	60	50	40	30
O2 sat	100%	98%	93%	90%	82%	65%	52%
pCO2	10	20	30	40	50	60	70

Normal dive


normal breathing
dive
normal breathing
O_2 level
CO_2 level
urgent need to breathe
high CO_2 triggers breathing
O_2 blackout zone

Dive with hypocapnia



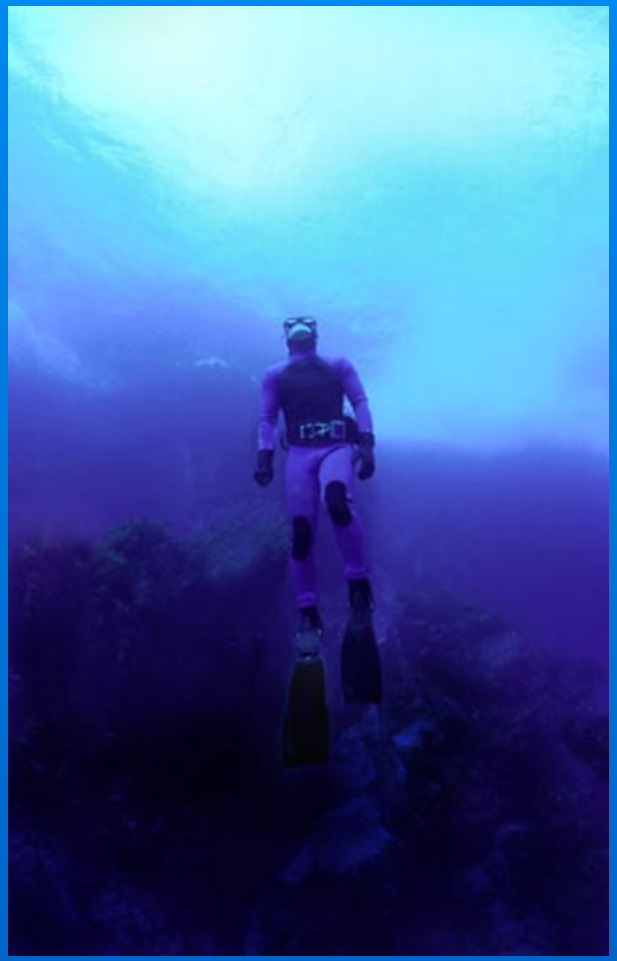
Guinness world record for breath holding underwater

- 11:35 min !!!

  (Stéphane Mifsud from France in June 2009)

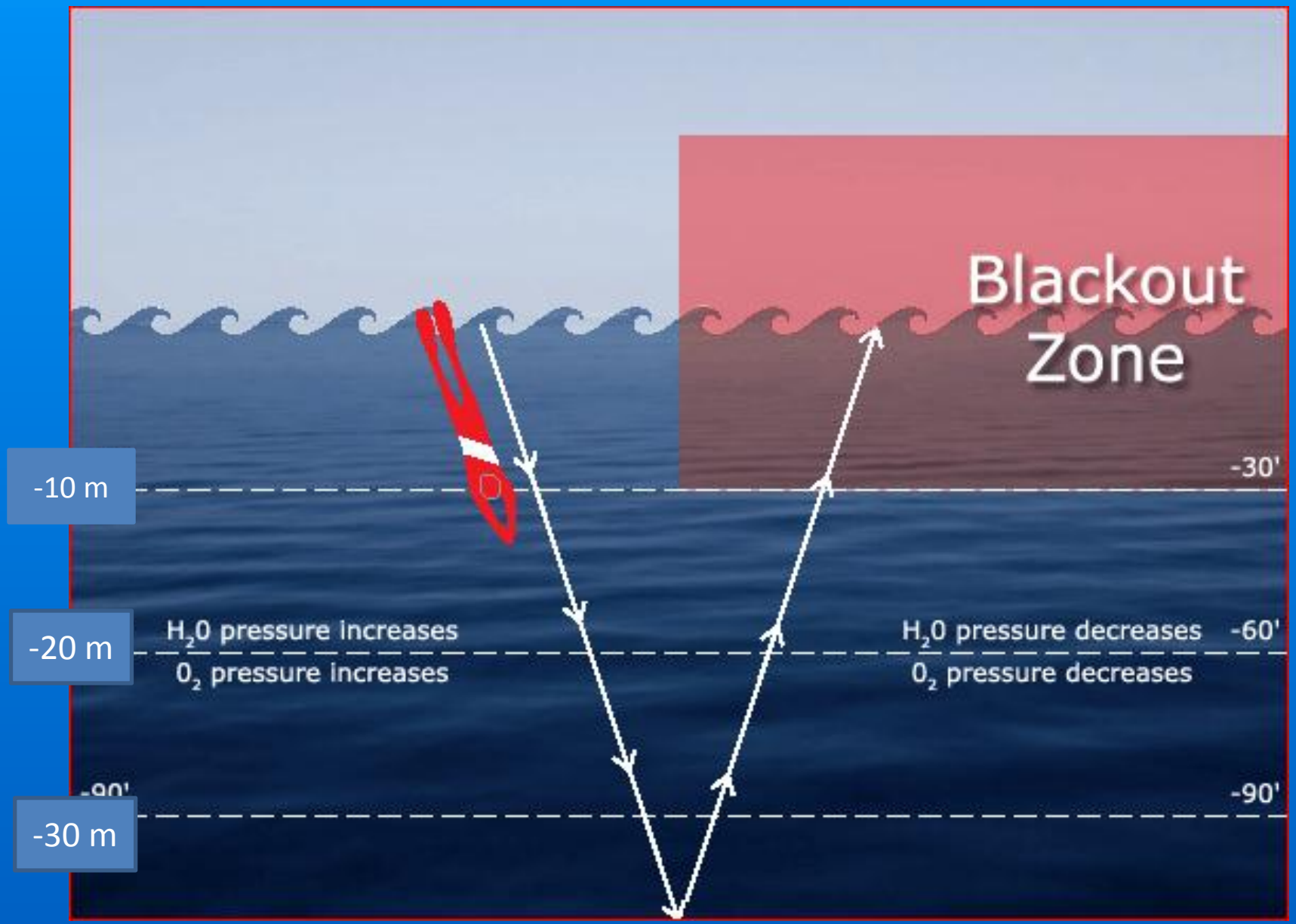
Deep free-diving blackout

- A young recreational free diver in a resort area took a deep dive for spear fishing.
- After 1 min of descent and stay at the depth of 18 meters he began to ascend.
- Very close to surface two fiends in a boat observed he is motionless.
- The victim immediately rescued and after a short bystander CPR regained full consciousness.
- He was unable to recall why he suddenly lost his consciousness near the surface !!



Deep Free-diving blackout

- Occurs during ascent following a breath-hold dive of over 10 m
- Involves deep, free-divers practicing dynamic apnea depth diving usually at sea
- The immediate cause of deep water blackout is the rapid drop in the paO2 in the lungs on ascent


Blackout Zone
-10 m
-30'
-20 m
H_20 pressure increases
0_2 pressure increases
H_20 pressure decreases
0_2 pressure decreases
-60'
-90'
-30 m

Gas pressures during ascent after a deep free-dive

Time (sec)	60’	65’	70’	75’	80’	85’	90’
Depth	-18 m	-15 m	-12 m	- 9 m	-6 m	- 3 m	0
paO2	70	61	52	43	34	25	16
O2 sat	93%	90%	84%	81%	70%	63%	50%
pCO2	55	53	51	48	47	45	43

Scuba diving black out

SCUBA: self-contained underwater breathing apparatus

Our story

- The Blue Hole is a popular diving location in the Red Sea at the Egypt coast.
- There is a cave at the depth of 130 m which connects the Blue Hole to the red sea.
- This site is notorious for the number of diving fatalities. So recognized as the "World's Most Dangerous Dive Site"
- There is an irresistible temptation for some people to go deep to see the cave

- Yuri Lipsky, a young scuba diving instructor, went for diving in the Blue Hole.
- He was equipped with compressed air cylinders and a head mounted camera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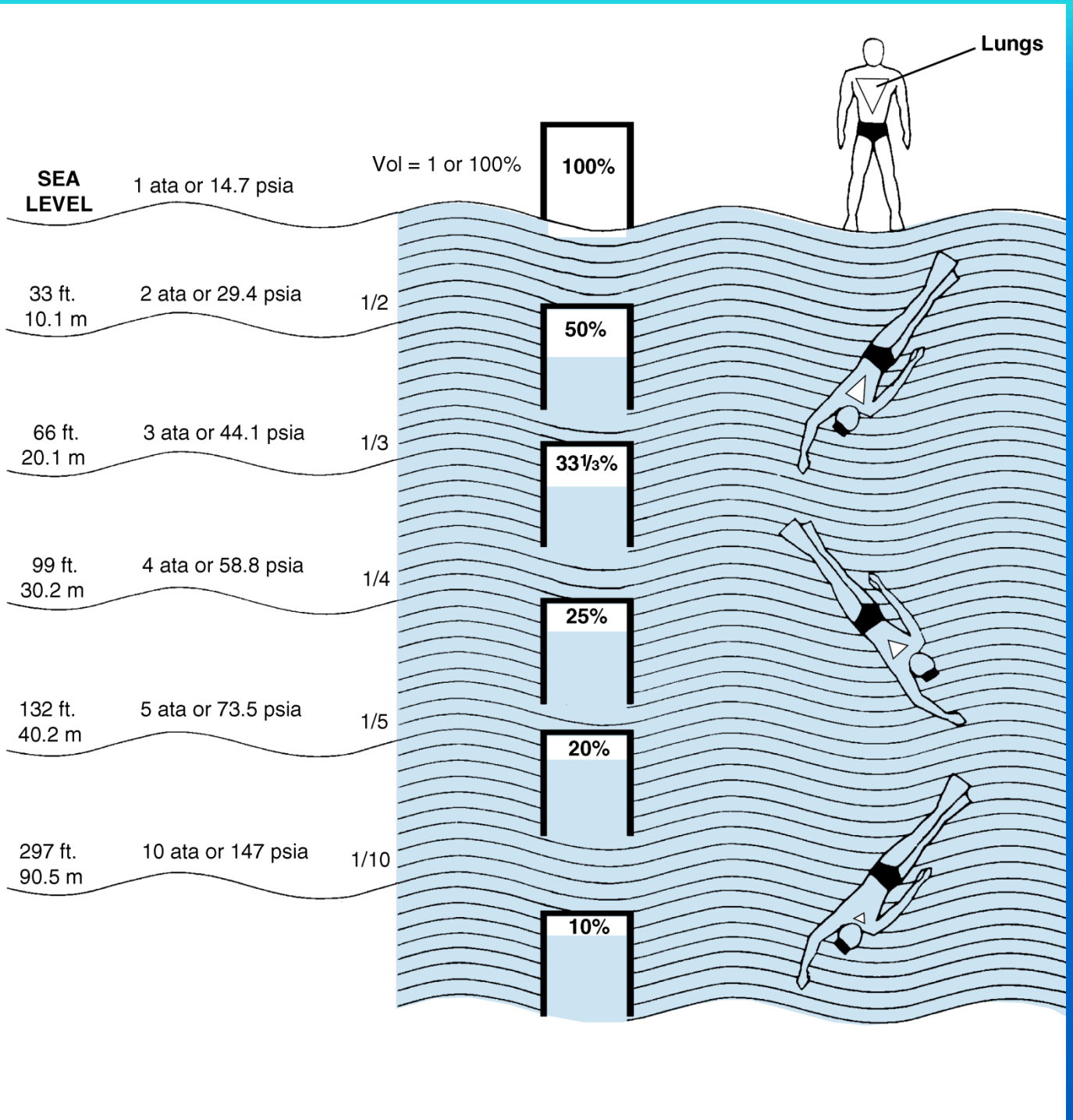
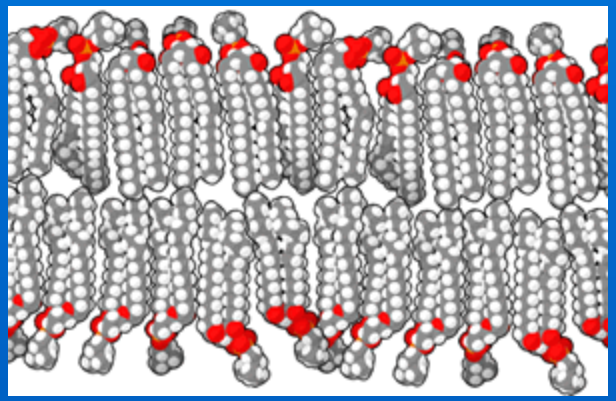

Lungs
SEA LEVEL
1 ata or 14.7 psia
Vol = 1 or 100%
100%
33 ft.
10.1 m
2 ata or 29.4 psia
1/2
50%
66 ft.
20.1 m
3 ata or 44.1 psia
1/3
33⅓%
99 ft.
30.2 m
4 ata or 58.8 psia
1/4
25%
132 ft.
40.2 m
5 ata or 73.5 psia
1/5
20%
297 ft.
90.5 m
10 ata or 147 psia
1/10
10%

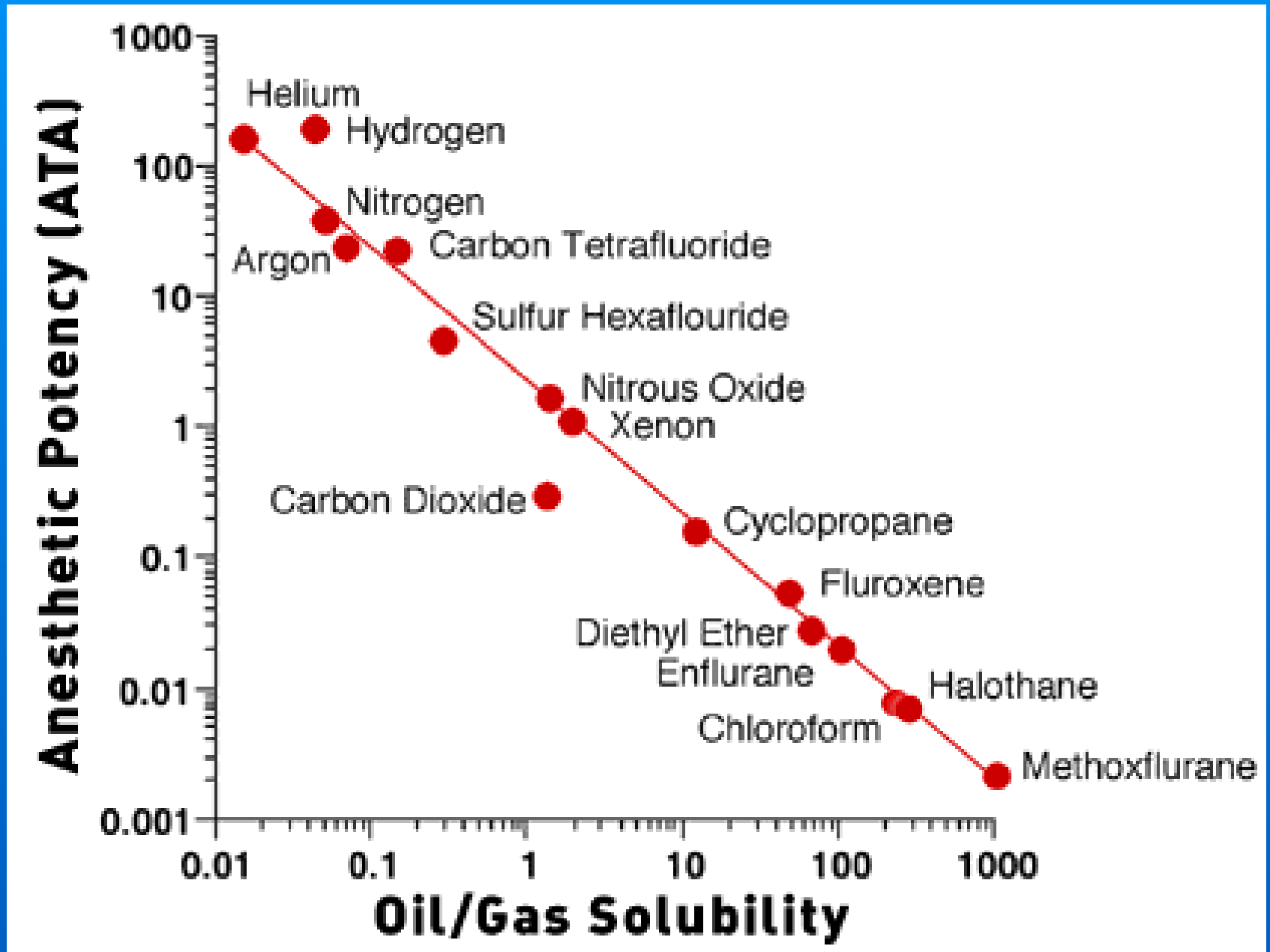
Nitrogen narcosis

Pressure (bar)	Depth (m)	pN2 (bar)	Comments
2	10	1.6	No symptoms
4	30	3.2	Minimally impaired reasoning
6	50	0.48	Mild euphoria, anxiety, mild reasoning impairment
8	70	0.64	Sleepiness, confusion, occasional dizziness
10	90	0.80	Deep confusion and Loss of memory
10+	90+	0.80+	Hallucination, unconsciousness, death

Cause of narcosis

- The breathing gas entering the diver's lungs will have the same pressure as the surrounding water
- Solubility of gases in body tissues increase as a result of the elevated pressures at depth
- Inert gases dissolve in the lipid bilayer of cell membranes causing alteration in neural conduction




Anesthetic Potency (ATA)
1000
100
10
1
0.1
0.01
0.001
Helium
Hydrogen
Nitrogen
Argon
Carbon Tetrafluoride
Sulfur Hexaflouride
Nitrous Oxide
Xenon
Carbon Dioxide
Cyclopropane
Fluroxene
Diethyl Ether
Enflurane
Halothane
Chloroform
Methoxflurane
0.01
0.1
1
10
100
1000
Oil/Gas Solubility

Some components of breathing gases and their relative narcotic potencies

Gas	Relative narcotic potency (ATM)
He	0.045
Ne	0.3
H_2	0.6
N_2	1.0
O_2	1.7
Ar	2.3
Kr	7.1
CO_2	20.0
Xe	25.6

What is the ideal gas for scuba diving?

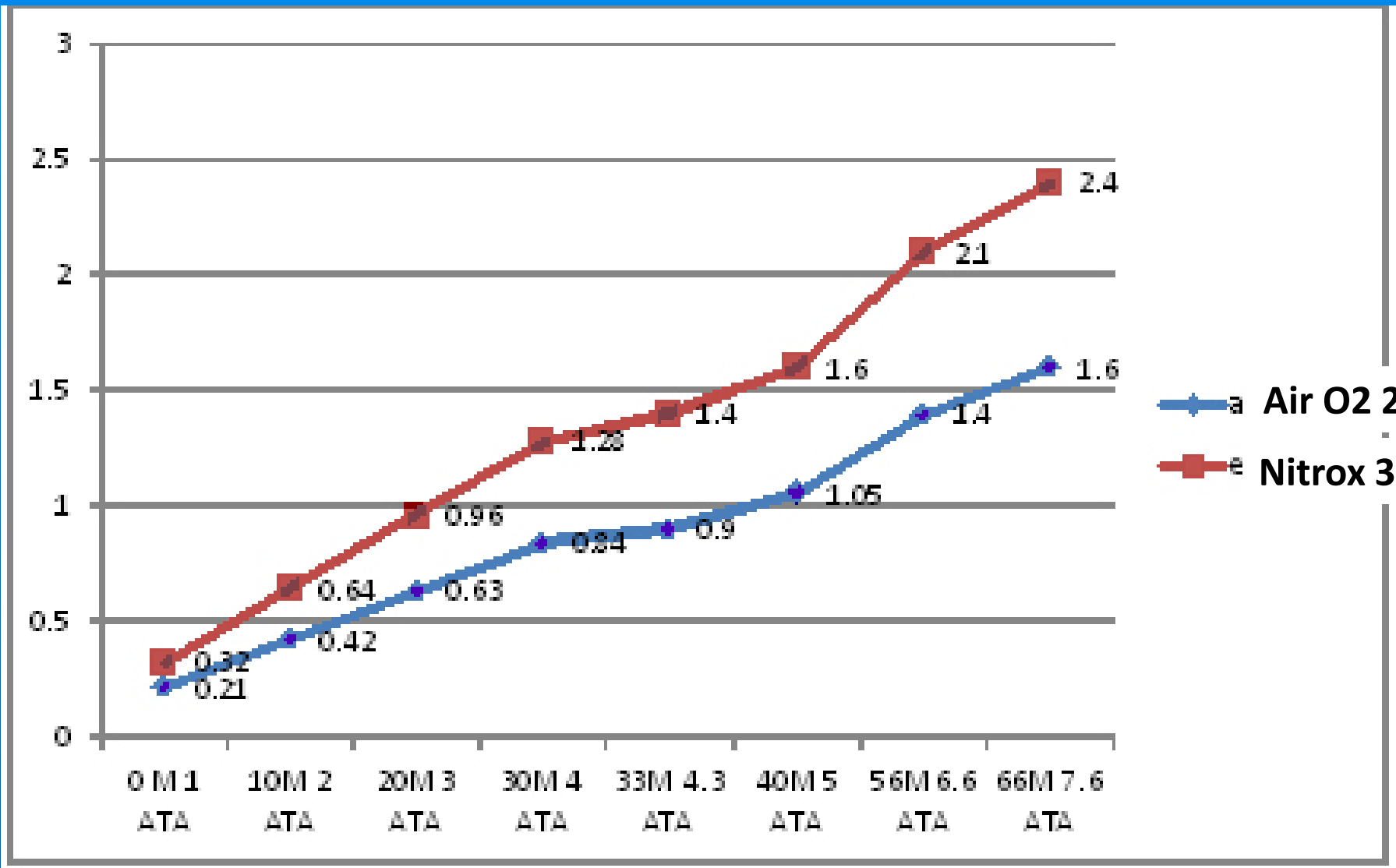
- Air O2 (21%) N2 (79%)
- Pure Oxygen O2 (100%) -----
- Nitrox mixture O2 (32%) N2 (68%)

- Our body is adapted to live with 0.21 bar oxygen pressure
- Ambient Oxygen pressure > 1.4 bar (2993 mmHg) can cause toxicity
- O2 toxicity is characterized by confusion, seizure and finally death
- The Oxygen toxicity begins by 60 m under water
- The ambient N2 pressure >3.2 bar can cause Nitrogen narcosis
- The Nitrogen narcosis begins from the depth of 30 m

Depth limits for N2 and O2 toxicities

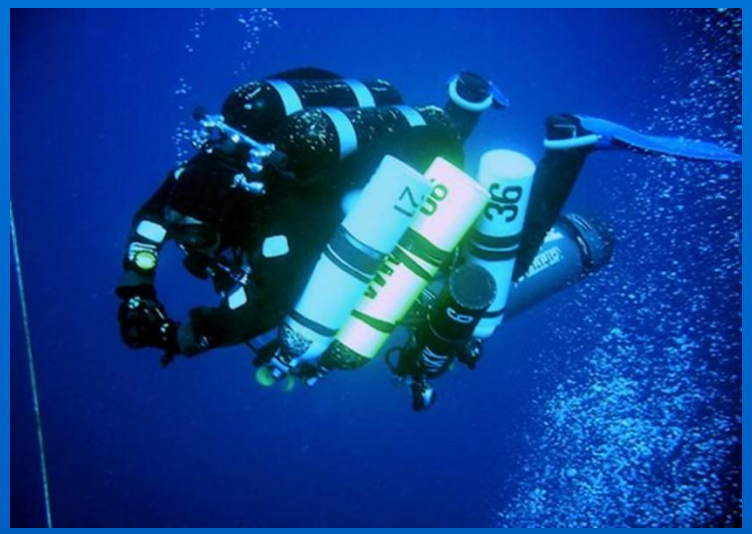
Water Depth	ATA	Volume	PO2	PN2
0	1	1	.21	.79
-10 m	2	1/2	.42	1.58
-20 m	3	1/3	.63	2.37
-30 m	4	1/4	.84	3.16
-40 m	5	1/5	1.05	3.95
-50 m	6	1/6	1.26	4.74
-60 m	7	1/7	1.47	5.53
-70 m	8	1/8	1.68	6.32
-80 m	9	1/9	1.89	7.11

Improving safe depth of diving with nitrox



Technical diving

- Defined as scuba diving at the depth of more than 40 m
- Usually needs more than 1 breathing mixtures
- Measures to avoid decompression sickness are required



Very deep diving – How is this possible?

By using Helium in the gas mixture

- Heliox (O_2 + He)
- Trimex (O_2 + N_2 + He)

Helium as scuba diving gas

- Advantages:
  - Low molecular weight
  - Negligible narcosis effect
- Disadvantages:
  - Expensive
  - More potential for decompression sickness

Holder of the Guinness record for deep scuba diving

- David (Dave) Shaw 270m on a rebreather !!
- Dave Shaw died (tragically) on Jan 8 2005 trying to recover the body of Deon Dreyer that he first discovered while making this record breaking dive.
- The story of this remarkable dive and this remarkable *man* is well documented in the book Raising the Dead by Philip Finch.

Thank you for your attention