Patho-physiology of nervous System Talk 2 – Syndromes in neurosciences

Petr Maršálek

Dept pathological physiology

1.Med. F. CUNI

Talks on NS

Talk 1 - Pain and Motor disorders

Talk 2 - This - Syndromes in neurosciences

Talk 3 - Disorders of special senses

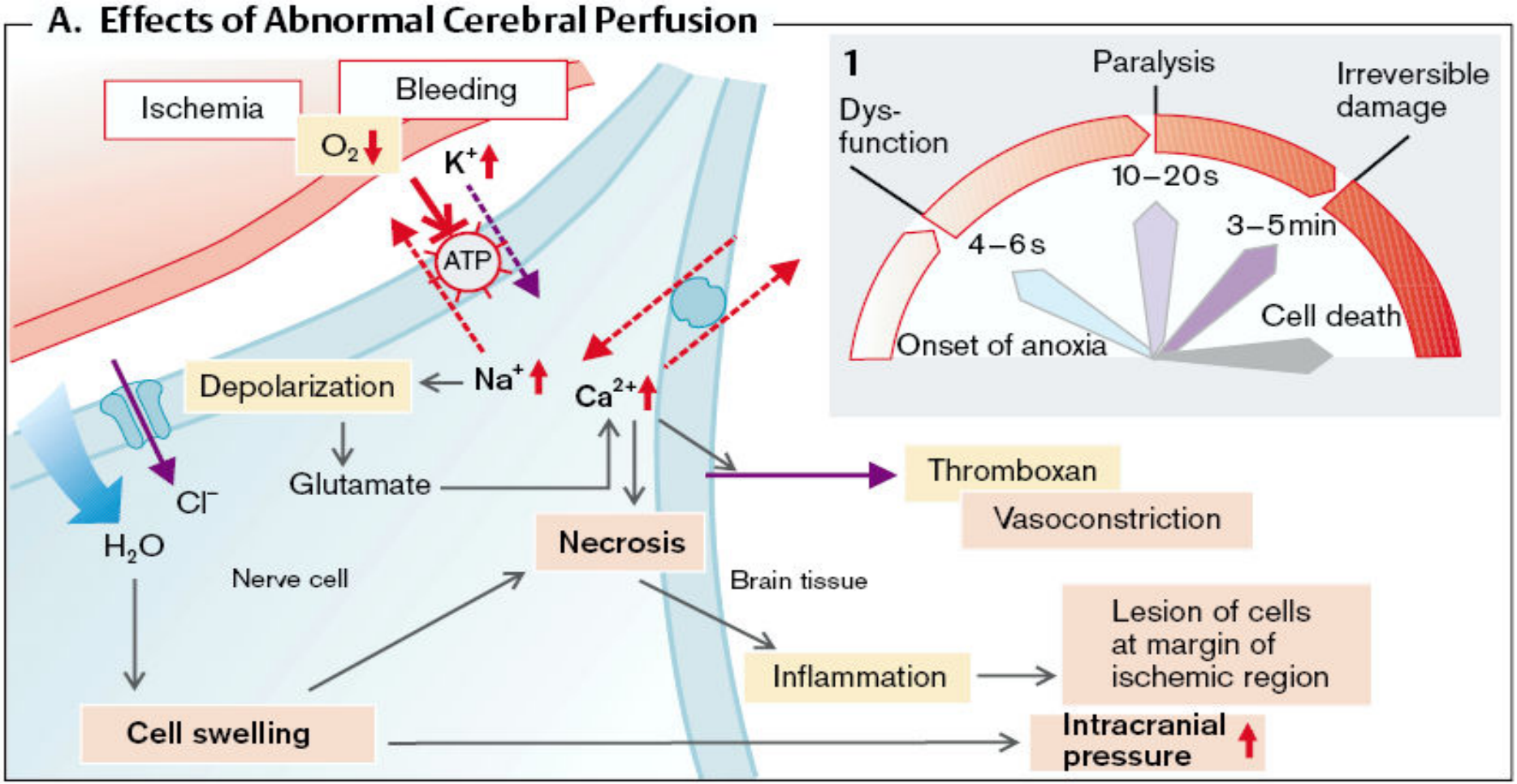
Talk 4 - Cognitive functions, dementias, etc.

Syndromes

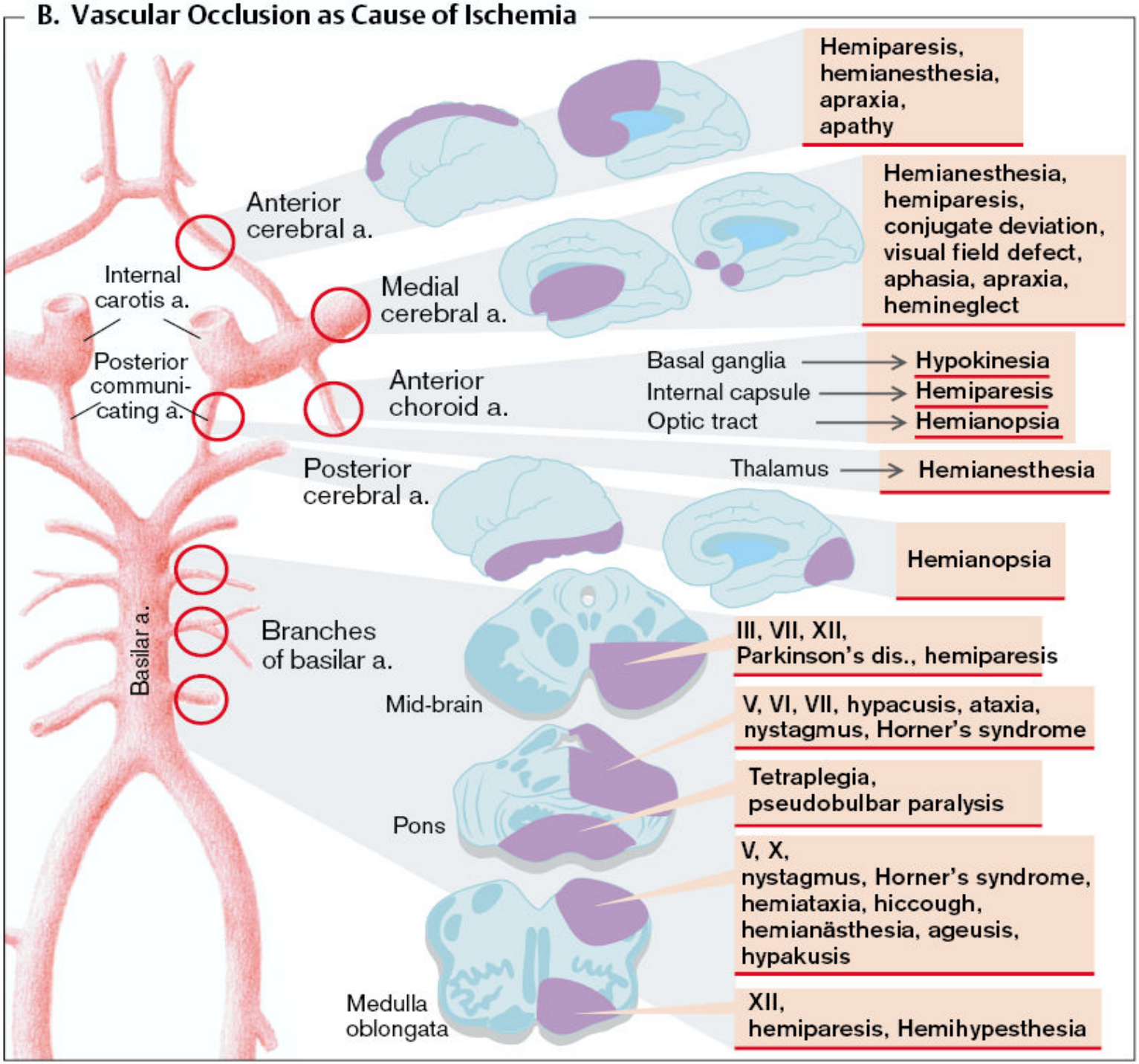
1) hypoxia of CNS
2) carbon mono-oxide poisoning
3) liquor circulation disorders
4) cerebral oedema
5) intra-cranial hypertension
6) intra-cranial hemorrhage
7) systemic neuro-muscular plate disorders
8) seizures – epilepsy and migraine
9) sleep/ wake cycle disorders
10) vomiting as a sign of NS

Cerebrovascular brain disease.

Hypo-perfusion, brain hypoxia



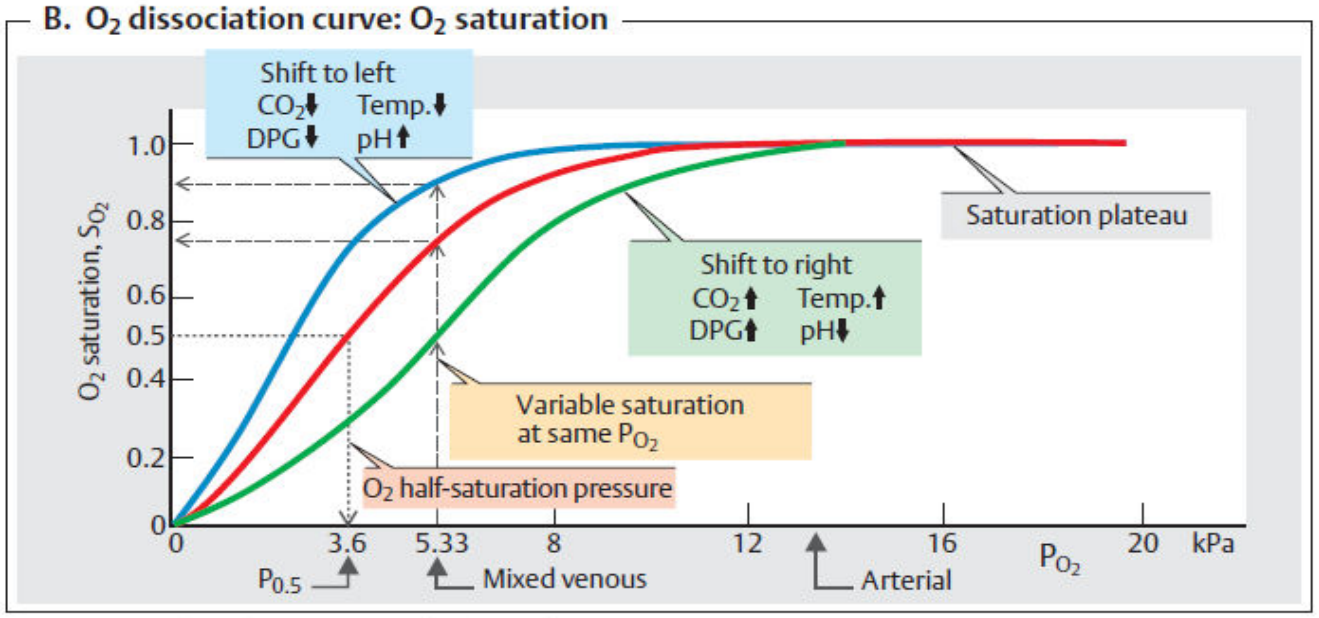
Topic signs

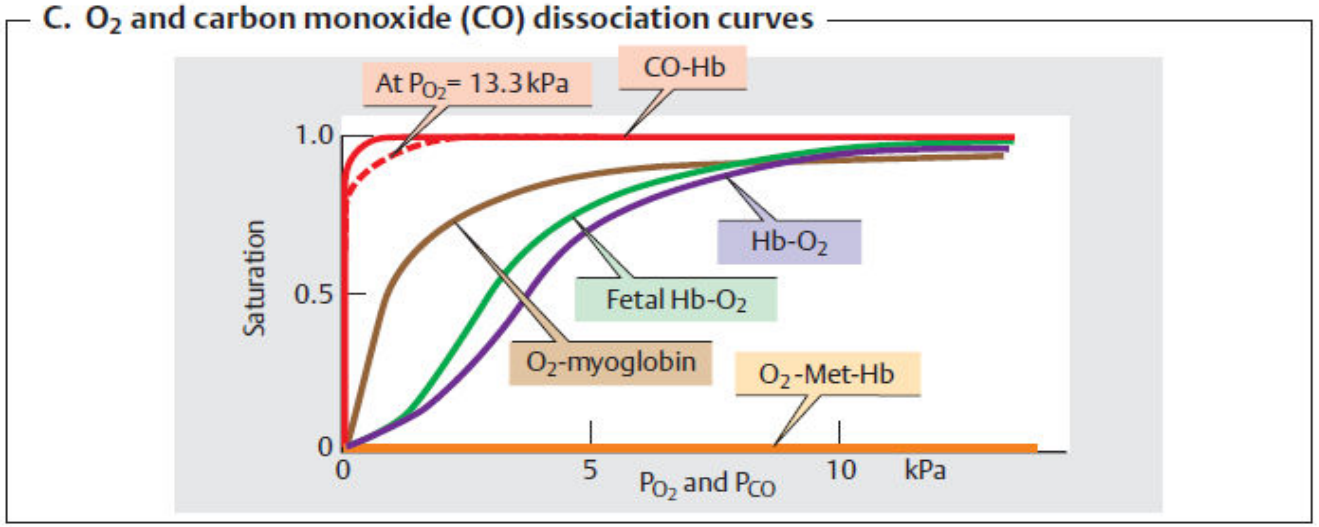

B. Vascular Occlusion as Cause of Ischemia
Anterior cerebral a.
Internal carotis a.
Posterior communi-cating a.
Medial cerebral a.
Anterior choroid a.
Posterior cerebral a.
Basilar a.
Branches of basilar a.
Mid-brain
Pons
Medulla oblongata
Hemiparesis, hemianesthesia, apraxia, apathy
Hemianesthesia, hemiparesis, conjugate deviation, visual field defect, aphasia, apraxia, hemineglect
Basal ganglia → Hypokinesia
Internal capsule → Hemiparesis
Optic tract → Hemianopsia
Thalamus → Hemianesthesia
Hemianopsia
III, VII, XII, Parkinson's dis., hemiparesis
V, VI, VII, hypacusis, ataxia, nystagmus, Horner's syndrome
Tetraplegia, pseudobulbar paralysis
V, X, nystagmus, Horner's syndrome, hemiataxia, hiccough, hemianästhesia, ageusis, hypakusis
XII, hemiparesis, Hemihypesthesia

Acute carbon-monooxide poisoning

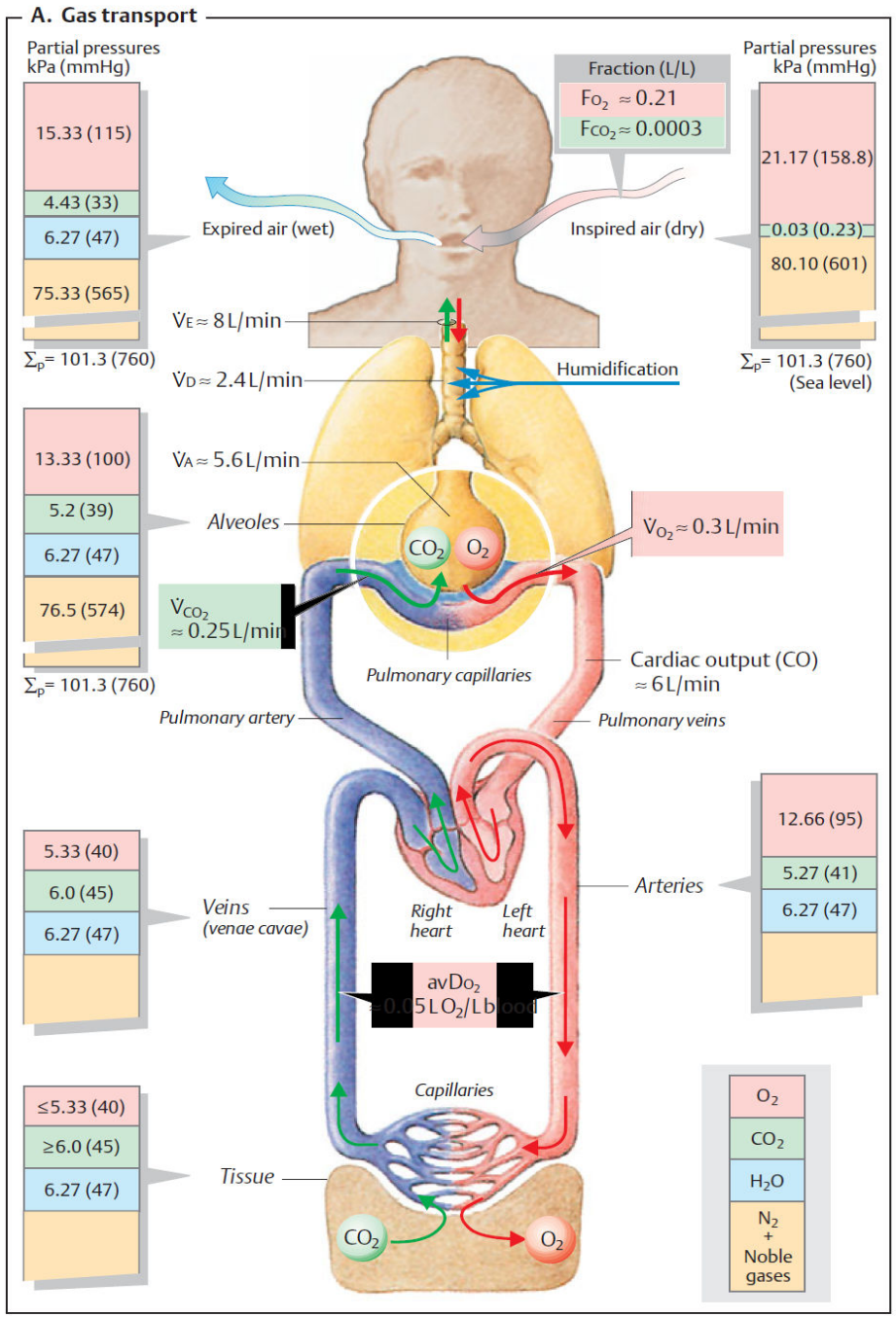
Concentration	Symptoms
35 ppm (0.0035%)	Headache and dizziness within six to eight hours of constant exposure
100 ppm (0.01%)	Slight headache in two to three hours
200 ppm (0.02%)	Slight headache within two to three hours; loss of judgment
400 ppm (0.04%)	Frontal headache within one to two hours
800 ppm (0.08%)	Dizziness, nausea, and convulsions within 45 min; insensible within 2 hours (700 ppm – Mars atmosphere)
1,600 ppm (0.16%)	Headache, tachycardia, dizziness, and nausea within 20 min; death in less than 2 hours
3,200 ppm (0.32%)	Headache, dizziness and nausea in five to ten minutes. Death within 30 minutes.
6,400 ppm (0.64%)	Headache and dizziness in one to two minutes. Convulsions, respiratory arrest, and death in less than 20 minutes.
12,800 ppm (1.28%)	Unconsciousness after 2-3 breaths. Death in less than three minutes.

Acute CO poisoning – blood gases affinity to Hb

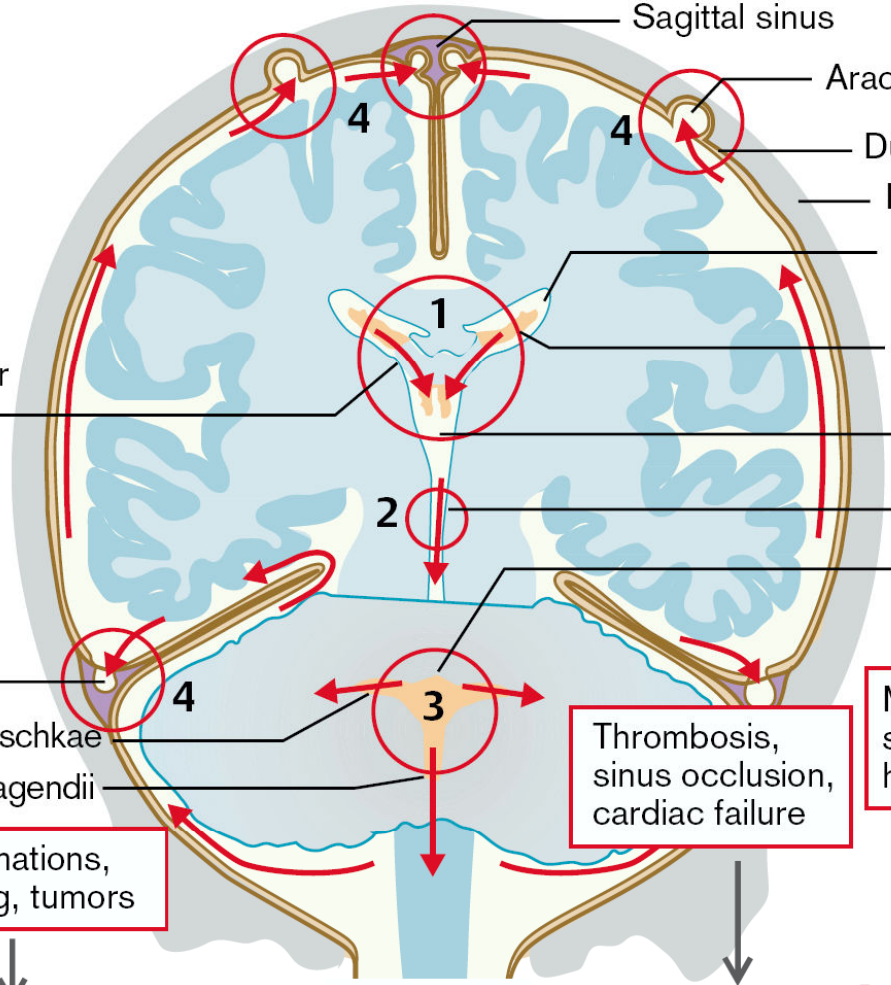




Blood gases


A. Gas transport
Partial pressures kPa (mmHg)
15.33 (115)
4.43 (33)
6.27 (47)
75.33 (565)
Σp= 101.3 (760)
Fraction (L/L)
FO2 ≈ 0.21
FCO2 ≈ 0.0003
Partial pressures kPa (mmHg)
21.17 (158.8)
0.03 (0.23)
80.10 (601)
Σp= 101.3 (760) (Sea level)
Expired air (wet)
Inspired air (dry)
V̇E ≈ 8 L/min
V̇D ≈ 2.4 L/min
Humidification
13.33 (100)
5.2 (39)
6.27 (47)
76.5 (574)
Σp= 101.3 (760)
V̇A ≈ 5.6 L/min
Alveoles
CO2
O2
V̇O2 ≈ 0.3 L/min
V̇CO2 ≈ 0.25 L/min
Pulmonary capillaries
Cardiac output (CO) ≈ 6 L/min
Pulmonary artery
Pulmonary veins
5.33 (40)
6.0 (45)
6.27 (47)
Veins (venae cavae)
Right heart
Left heart
Arteries
12.66 (95)
5.27 (41)
6.27 (47)
avDO2 ≈ 0.05 L O2/L blood
Capillaries
≤5.33 (40)
≥6.0 (45)
6.27 (47)
Tissue
CO2
O2
O2
CO2
H2O
N2 + Noble gases

A. Cerebrospinal Fluid (CSF) Flow



5

Hydrocephalus in newborn

Malformations, scarring, tumors

CSF flow obstructed

Hydrocephalus (non-communicating)

Thrombosis, sinus occlusion, cardiac failure

Venous outflow ↓

Meningitis, subarachnoid hemorrhage, etc.

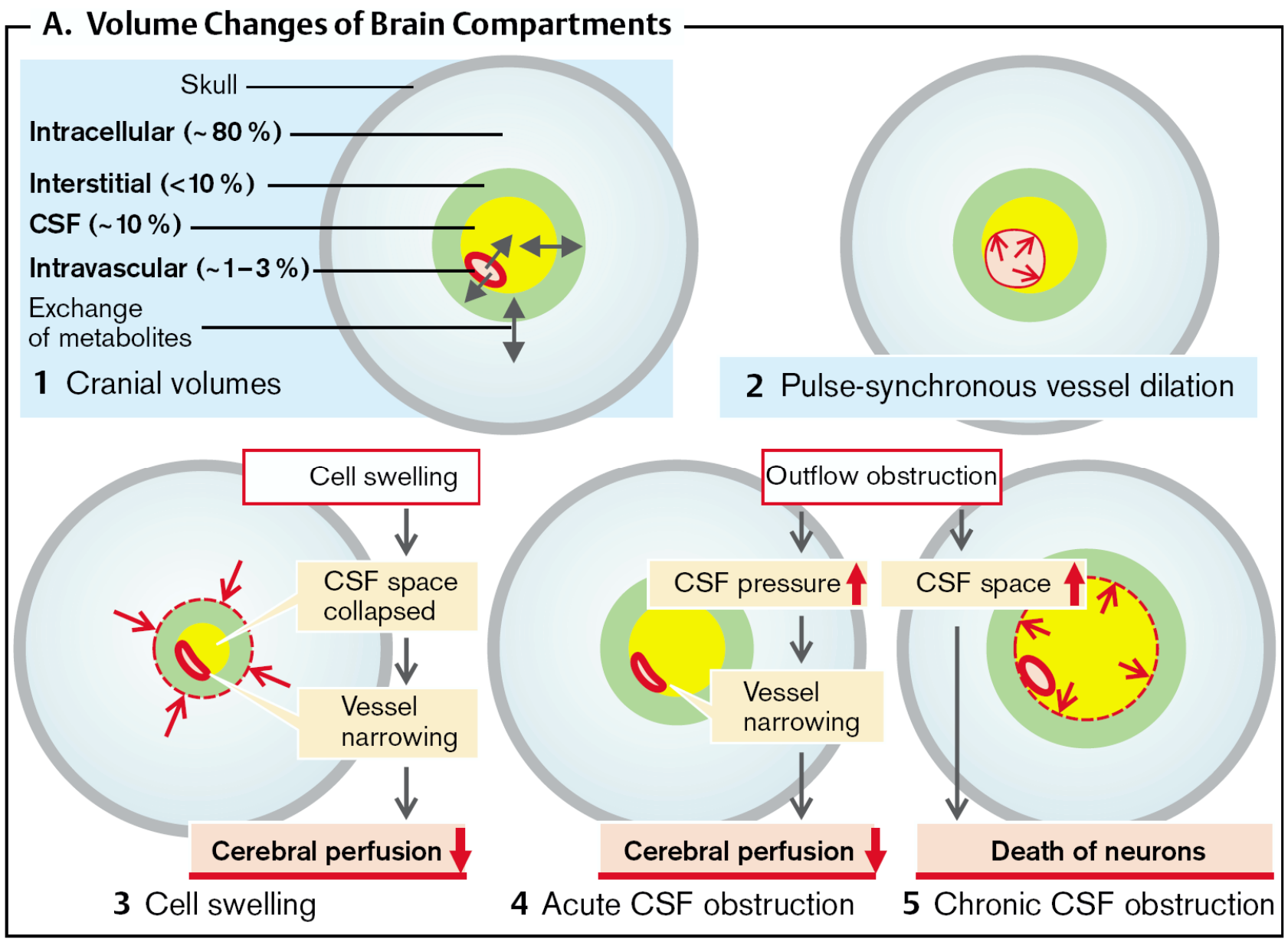
Tumors, infections

Protein concentration ↑

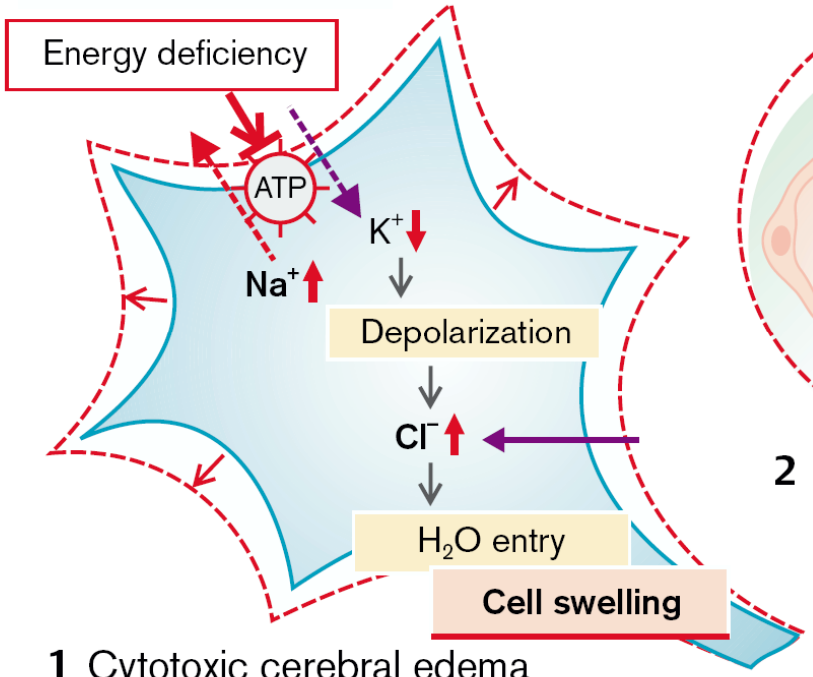
Obstruction of arachnoid villi

CSF absorption ↓

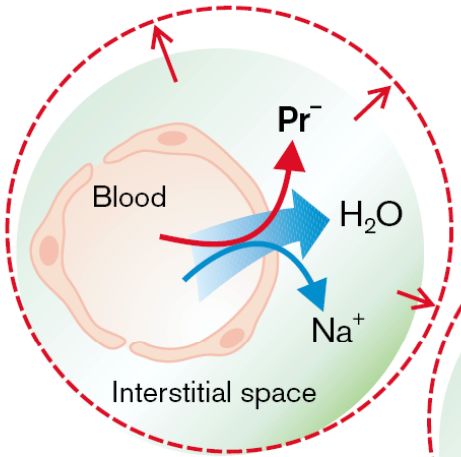
Hydrocephalus (communicating)


A. Volume Changes of Brain Compartments
Skull
Intracellular (~80 %)
Interstitial (<10 %)
CSF (~10 %)
Intravascular (~1–3 %)
Exchange of metabolites
1 Cranial volumes
2 Pulse-synchronous vessel dilation
Cell swelling
CSF space collapsed
Vessel narrowing
Cerebral perfusion
3 Cell swelling
Outflow obstruction
CSF pressure
Vessel narrowing
Cerebral perfusion
4 Acute CSF obstruction
CSF space
Death of neurons
5 Chronic CSF obstruction

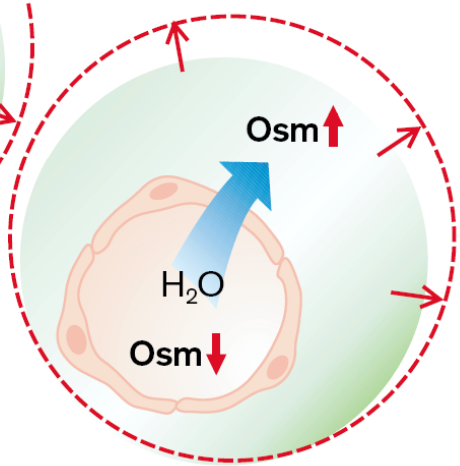
B. Cerebral Edema



1 Cytotoxic cerebral edema



2 Of vascular origin



3 Interstitial

C. Effects of Increased Intracranial Pressure

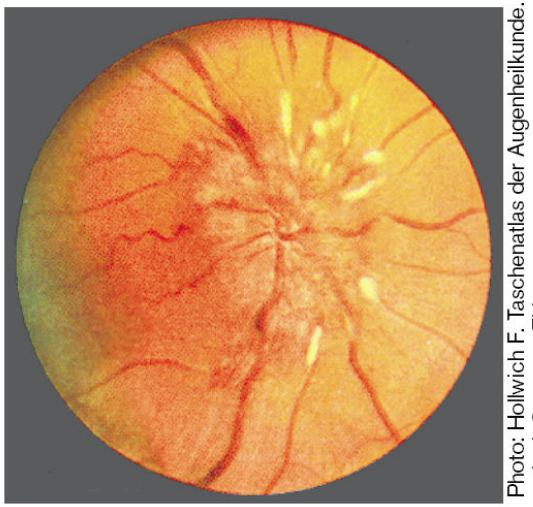
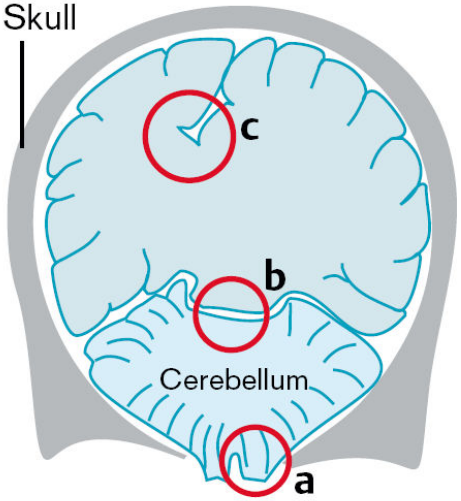


Photo: Hollwich F. Taschenatlas der Augenheilkunde. 3rd ed. Stuttgart: Thieme; 1987

1 Papilledema

- Headache
- Nausea
- Vomiting
- Coma
- Bradycardia
- Hypertension
- Squint
- Fixed pupils

2 Additional effects



3 Herniation

Intracranial hypertension,

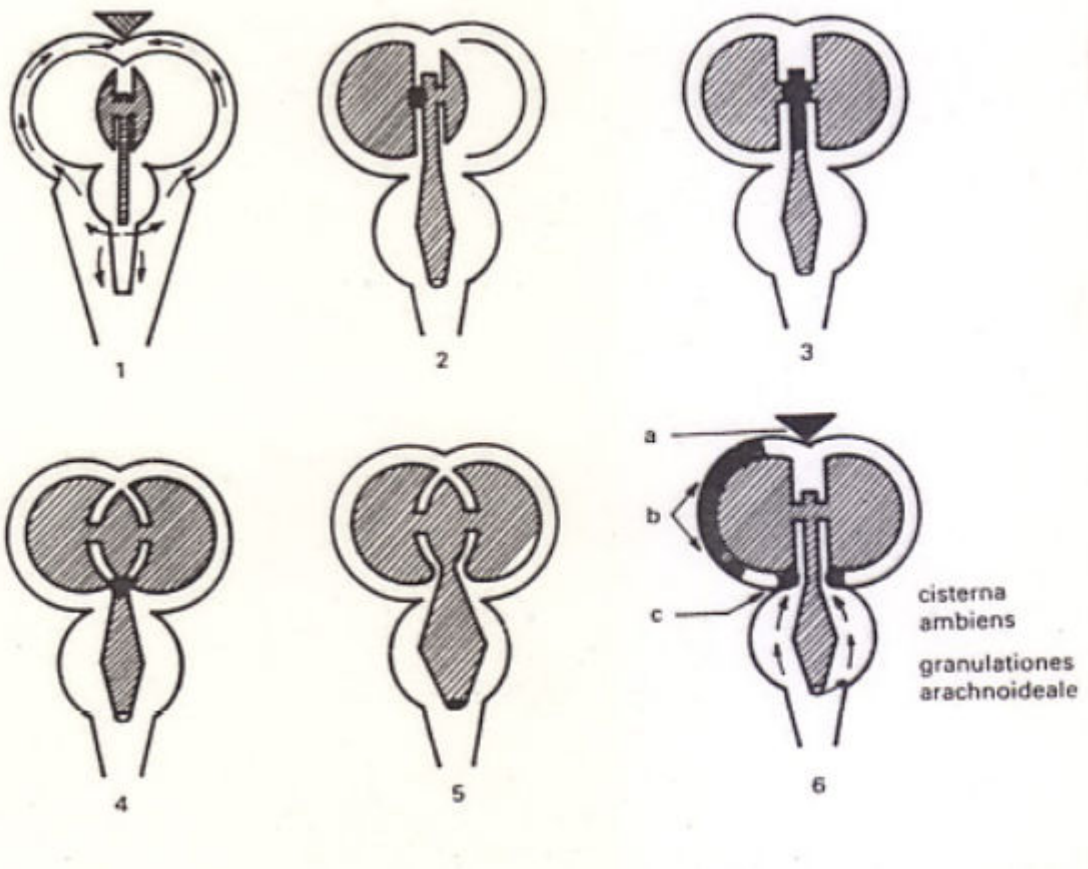
subjective signs

headache, nausea, vomiting, blurred vision

objective signs

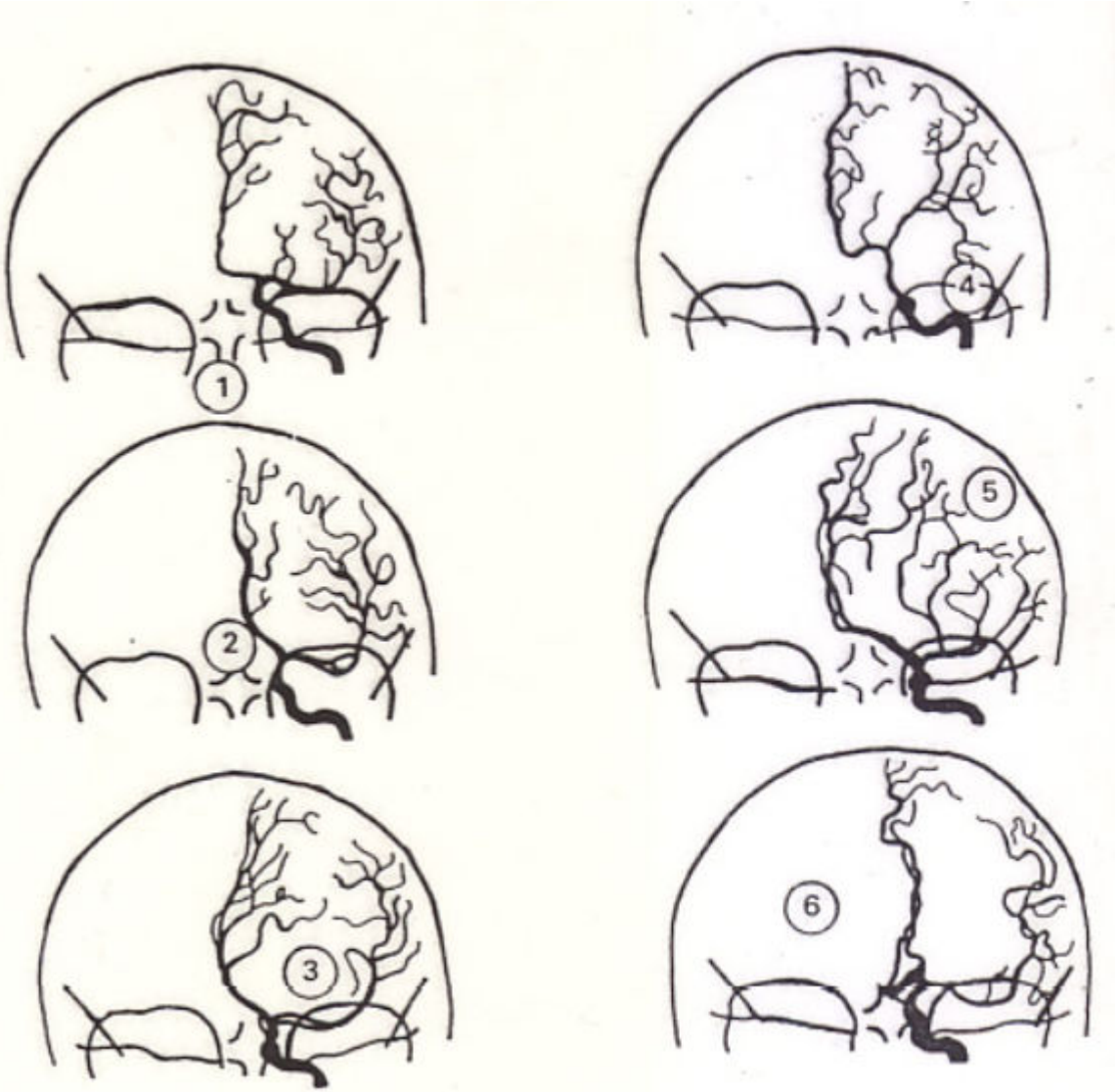
vomiting, papilla nervi optici (n. II)
bradycardia, hypertension, loss of consciusness, coma

Obstructive hydrocephalus



Obr. 56. Rozličné príčiny vzniku obštrukčného hydrocefalu
1 – normálna cirkulácia likvoru, 2 – uzáver foramen interventriculare, 3 – uzáver III. komory, 4 – uzáver v oblasti corpora quadrigemina, 5 – uzáver na konci IV. komory, 6 – uzáver vonkajších likvorových ciest

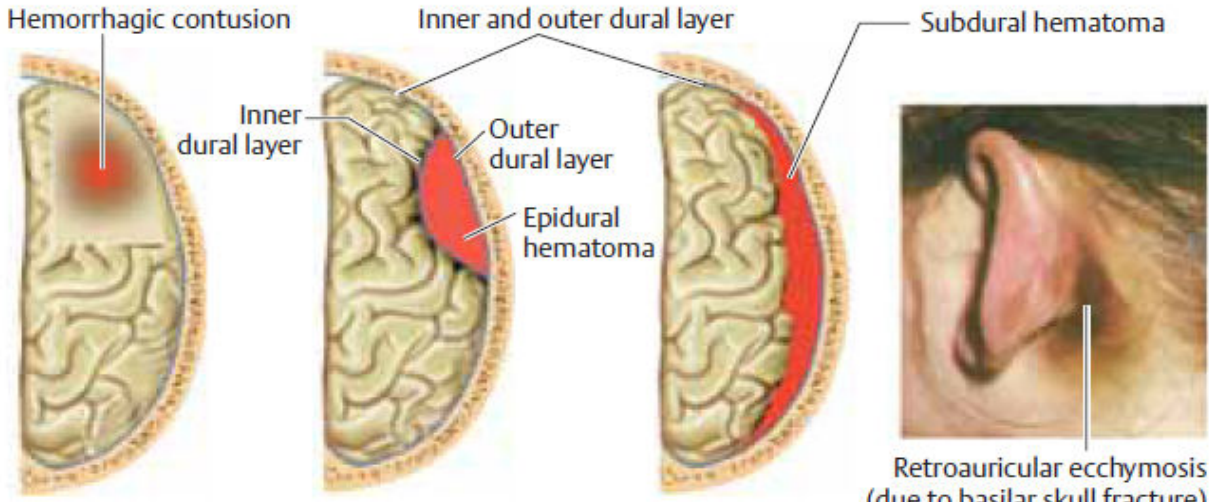
Angiografic findings in intra-cranial expansions (Bartko, 1985)



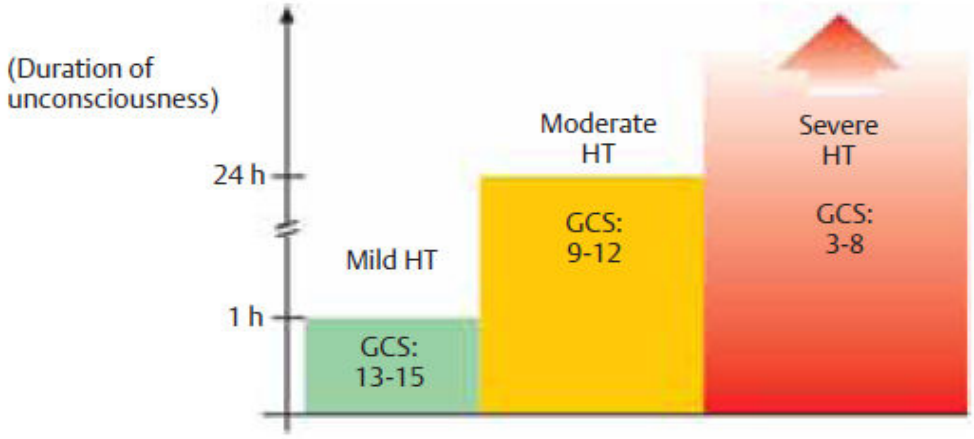
Obr. 55. Schéma angiografie a. carotis interna v predozadnej projekcii pri intrakraniálnych expanzívnych procesoch rozličnej lokalizácie

1 – normálny nález, 2 – expanzívny proces v preselárnej oblasti, 3 – expanzívny proces v čelovom laloku, 4 – expanzívny proces v temporálnom laloku, 5 – angiografický nález pri subdurálnom hematóme, 6 – angiografický nález pri expanzívnom procese na strane protiľahlej angiografii (po-

Intracranial hemorrhage



Traumatic intracranial hematoma



Classification of head trauma (HT) **by Glasgow Coma Scale** (GCS)

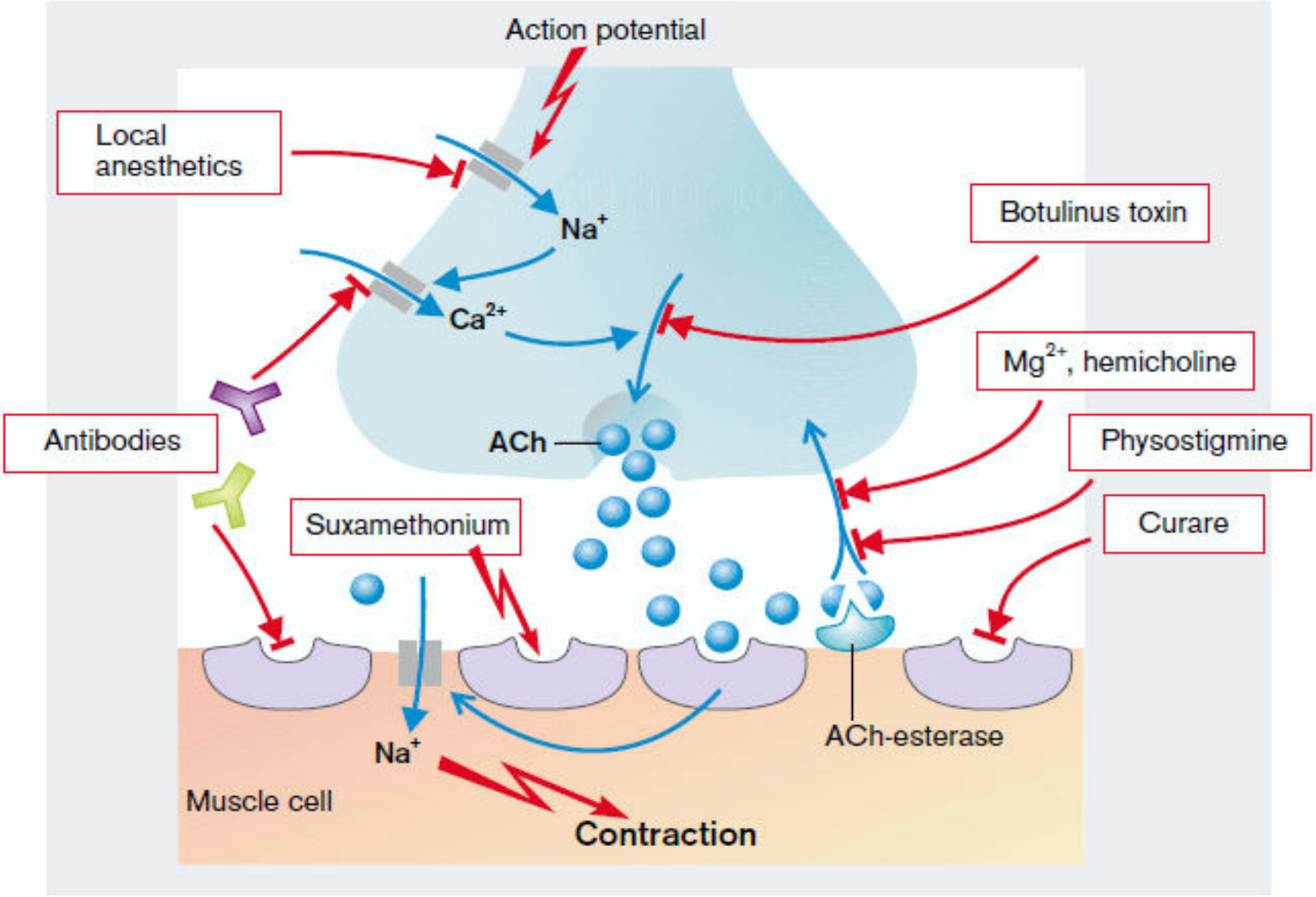
Glasgow coma scale

Glasgow Coma Scale

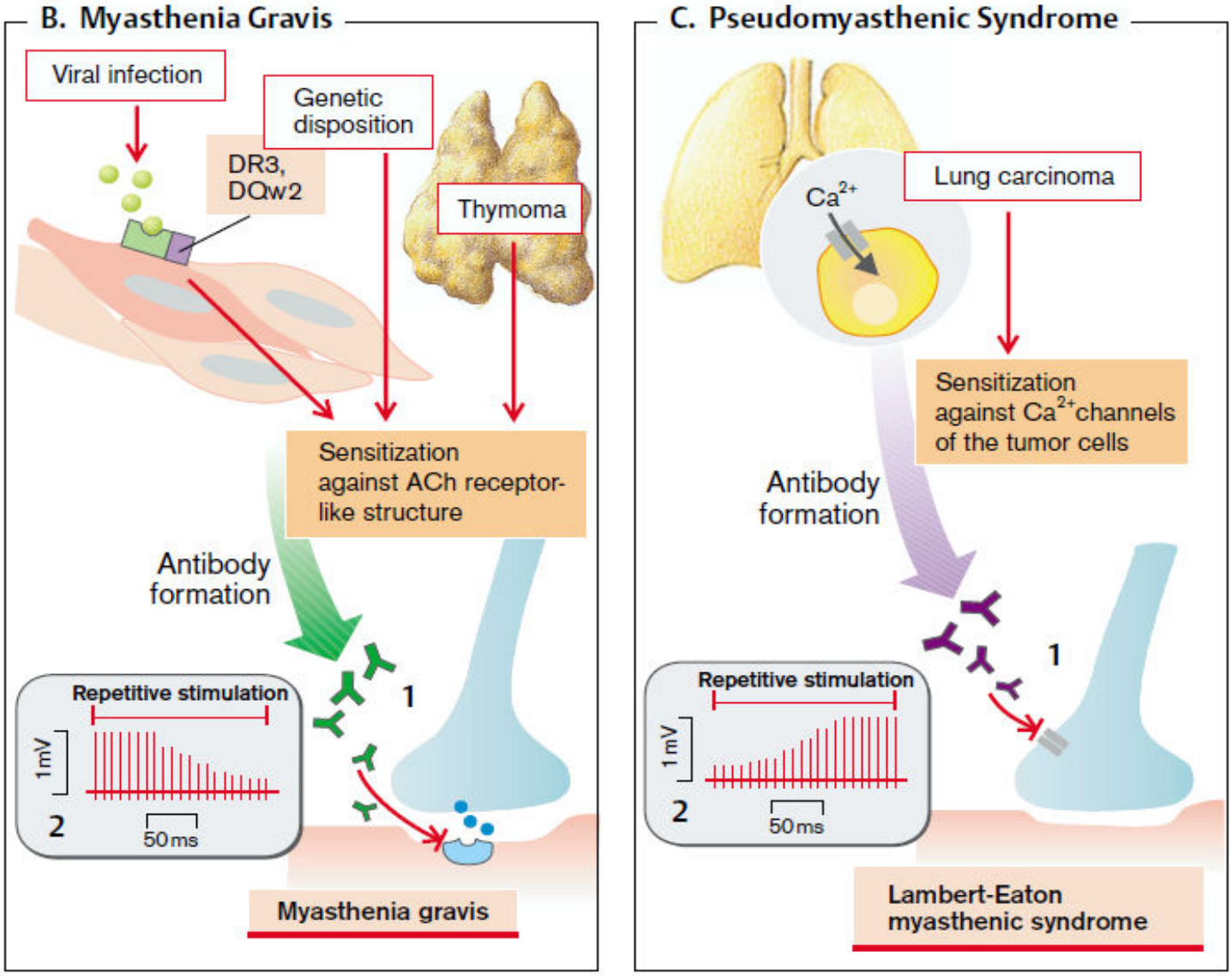
	1	2	3	4	5	6
Eyes	Does not open eyes	Opens eyes in response to painful stimuli	Opens eyes in response to voice	Opens eyes spontaneously	N/A	N/A
Verbal	Makes no sounds	Incomprehensible sounds	Utters inappropriate words	Confused, disoriented	Oriented, converses normally	N/A
Motor	Makes no movements	Extension to painful stimuli (decerebrate response)	Abnormal flexion to painful stimuli (decorticate response)	Flexion / Withdrawal to painful stimuli	Localizes painful stimuli	Obeys commands

The scale comprises three tests: eye, verbal and motor responses. The three values separately as well as their sum are considered. The lowest possible GCS (the sum) is 3 (deep coma or death), while the highest is 15 (fully awake person).

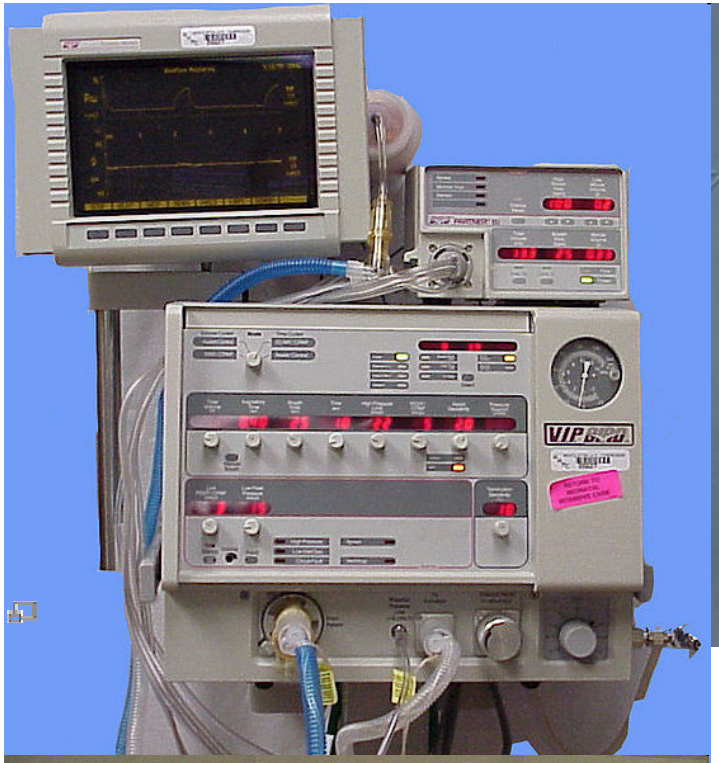
Disorders of Neuromuscular transmission

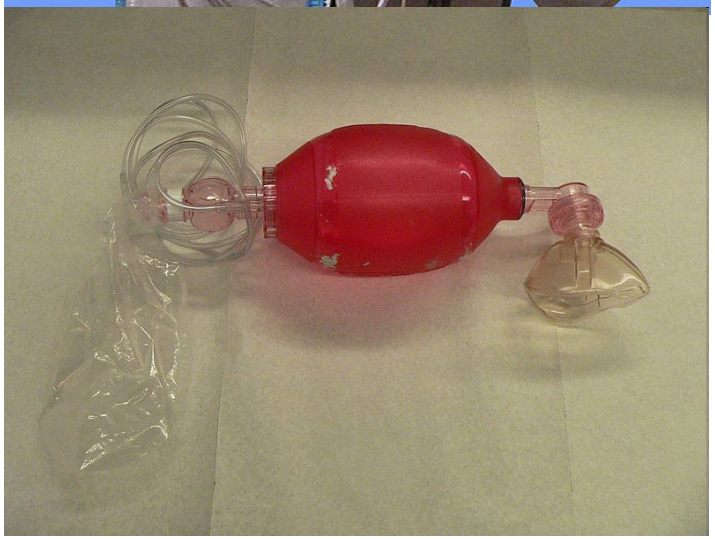


Disorders of Neuromuscular transmission



Artificial ventilation/ Iron lung



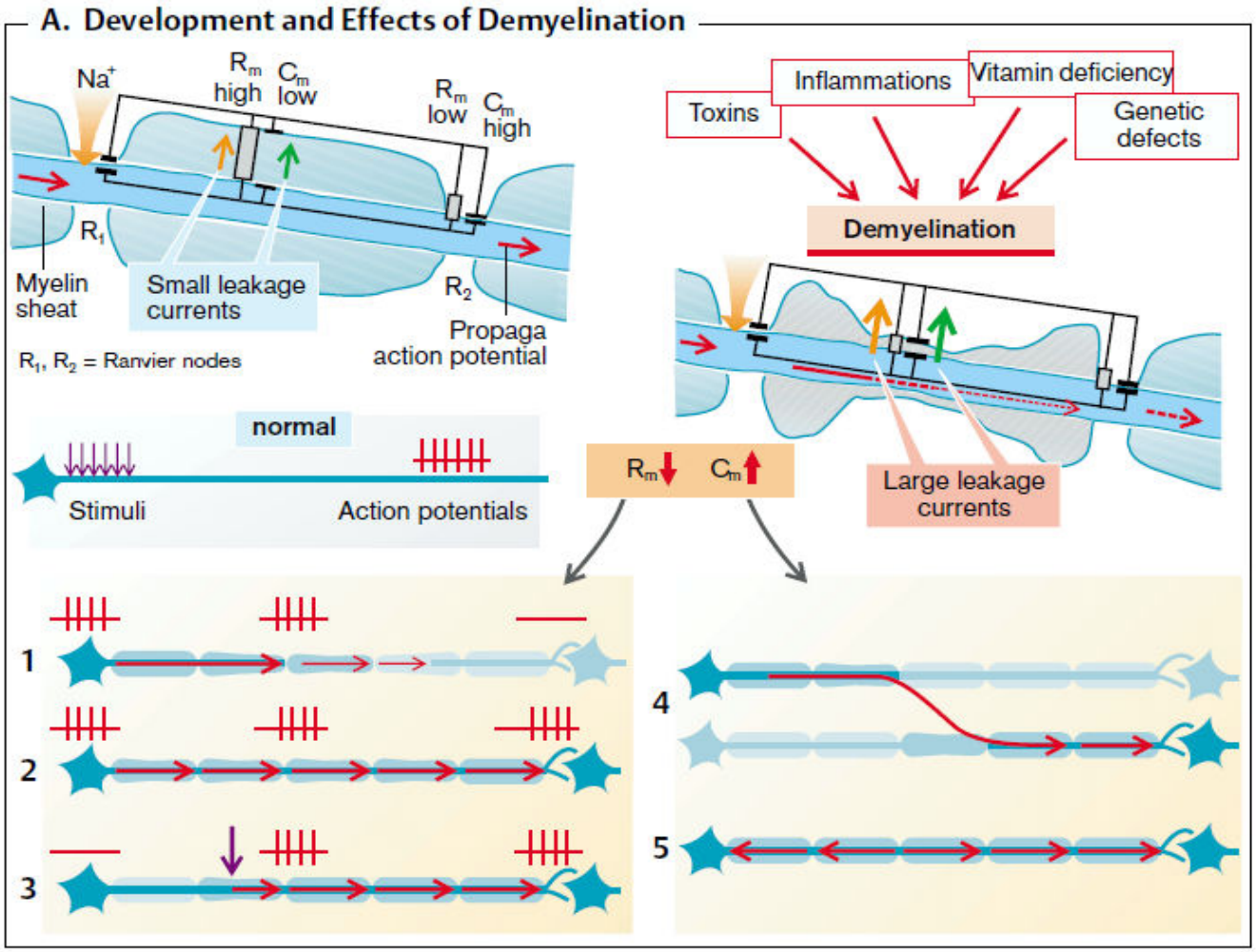


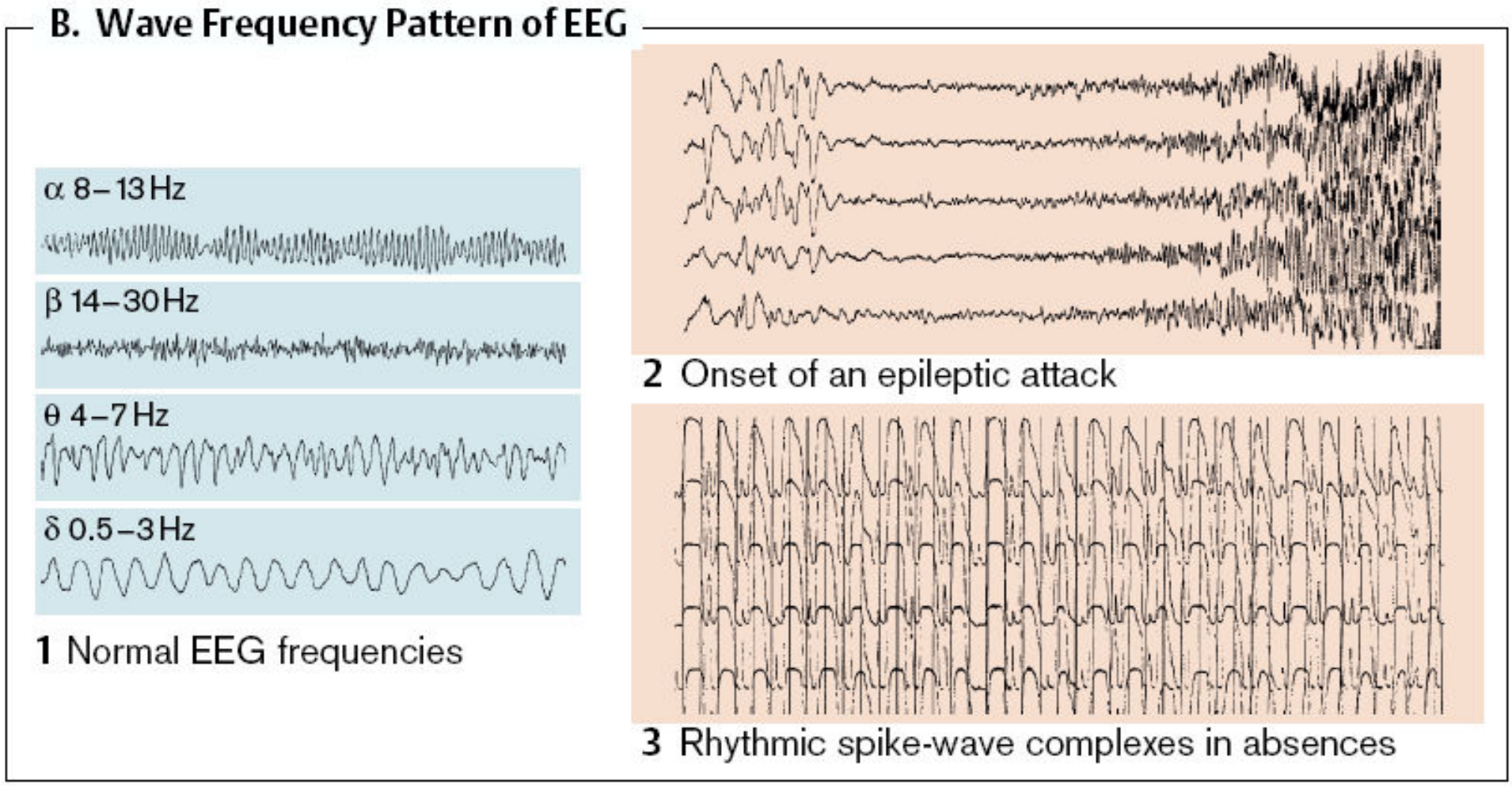
Ventilation can be delivered via:

Hand-controlled ventilation such as: Bag-Valve-Mask Resuscitator Continuous-flow or Anaesthesia (or T-piece) bag

- A mechanical ventilator.
- Iron lung is a historical type of mechanical ventilator

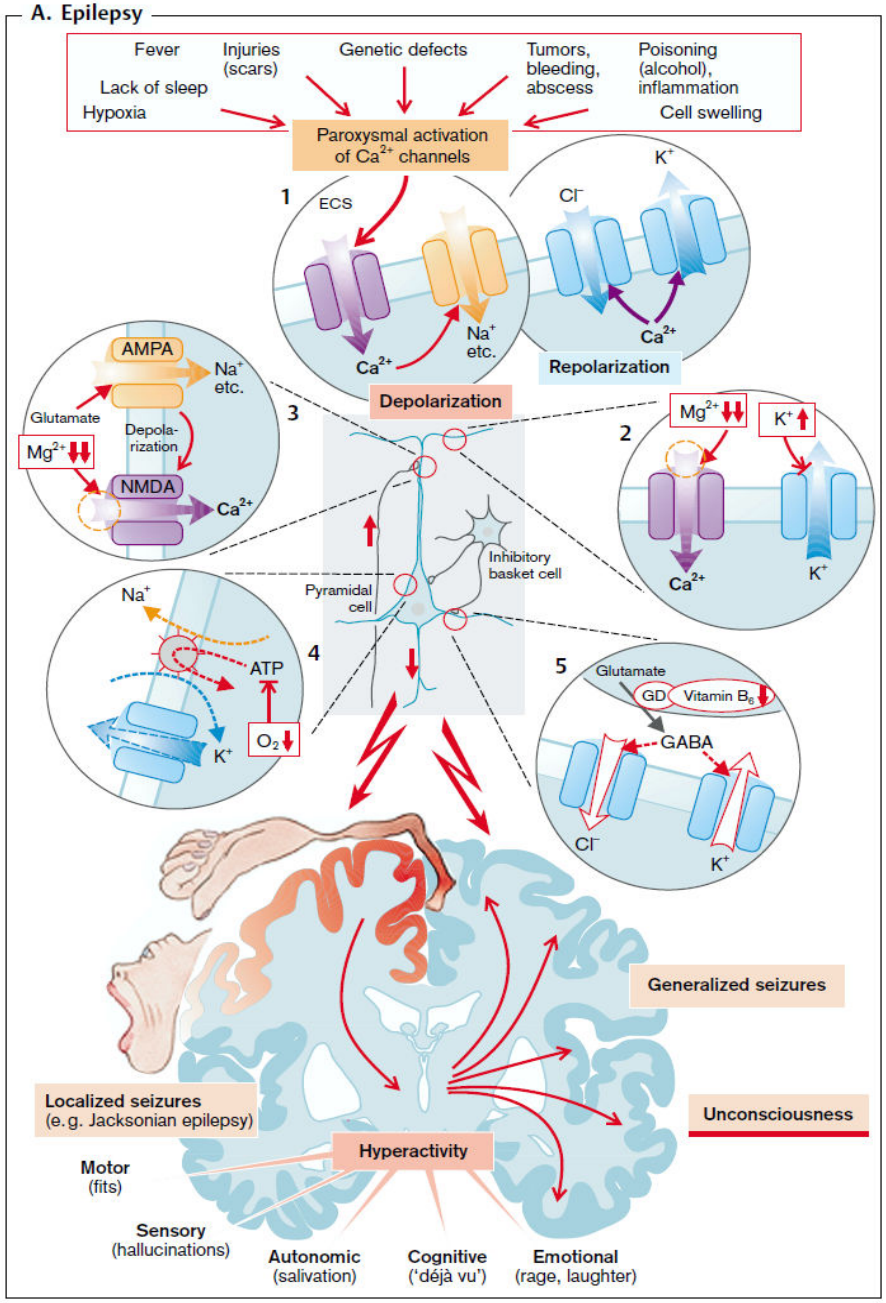
Demyelination – sclerosis multiplex





Normal findings: EEG waves:

Alpha waves, 8-13 Hz, parieto-occipital region, marked in closed eyes
Beta waves, 14-30 Hz, frontal region
Gamma waves, 40-60 Hz, are not regularly used due to interference with electric power net.
Delta waves, < 4 Hz, e.g in synchronous phase of sleep.
Theta waves, 4-7 Hz, e.g in synchronous phase of sleep.



Epilepsy:

Cortico-Thalamic

and Thalamo-cortical feedback system modulating sensory inputs

Migraine – phosphenes

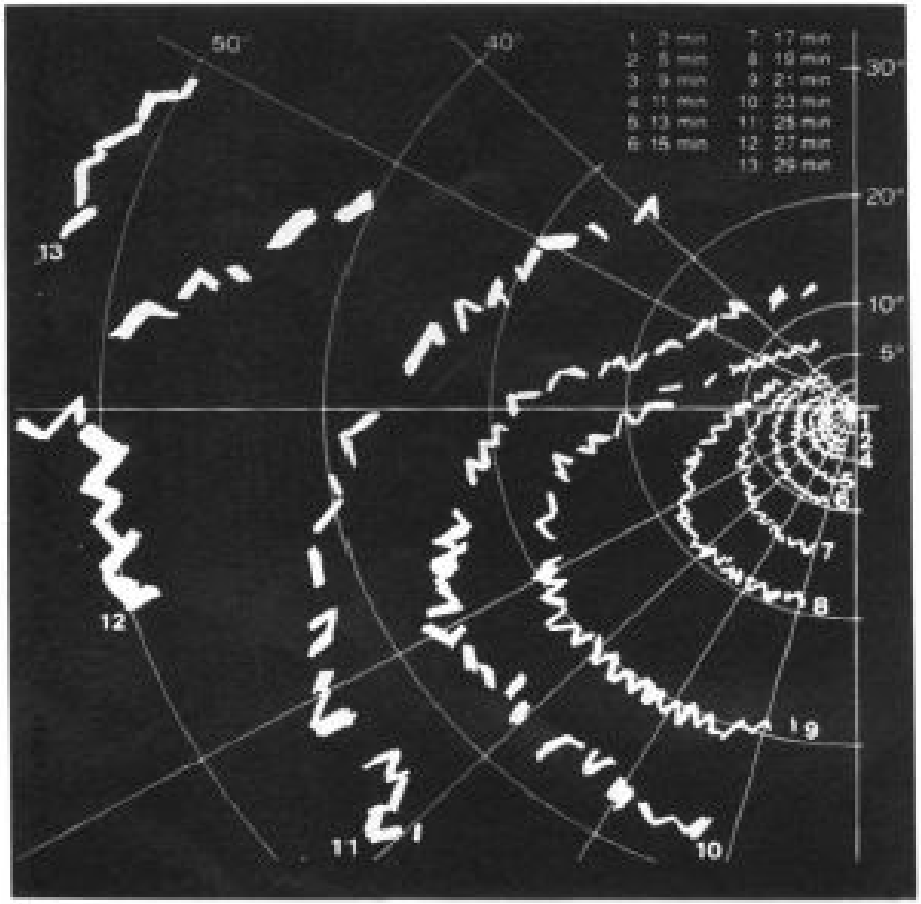
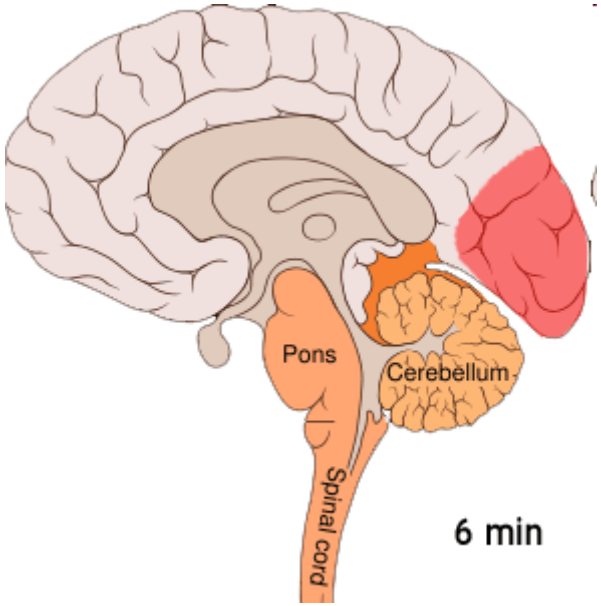


FIGURE 1. Photographic negative of a *migraine phosphene protocol*. The scintillating phosphene was progressing through the lower quadrant and part of the upper quadrant of the left visual hemifield. Thirteen drawings were made between 2 and 29 min after the phosphene appeared near the centre of the visual field. To evaluate the distance between the migraine phosphene and the centre of the visual field, several radii were drawn across the protocol. The angular distance from the fovea centre, computed in degrees of visual angle, is indicated by circles. Circles and radii were added to the protocol sheet after the observations were made. Observation distance, 34 cm.



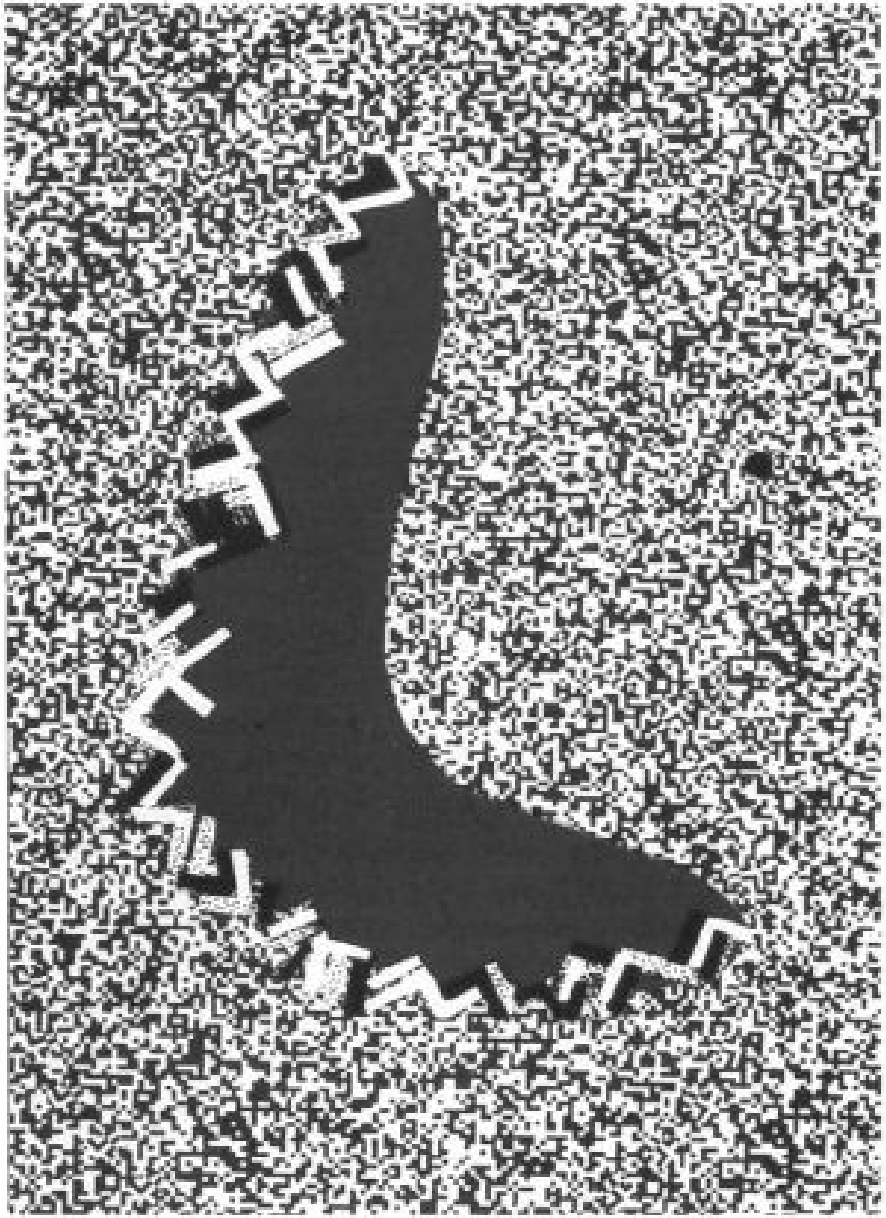
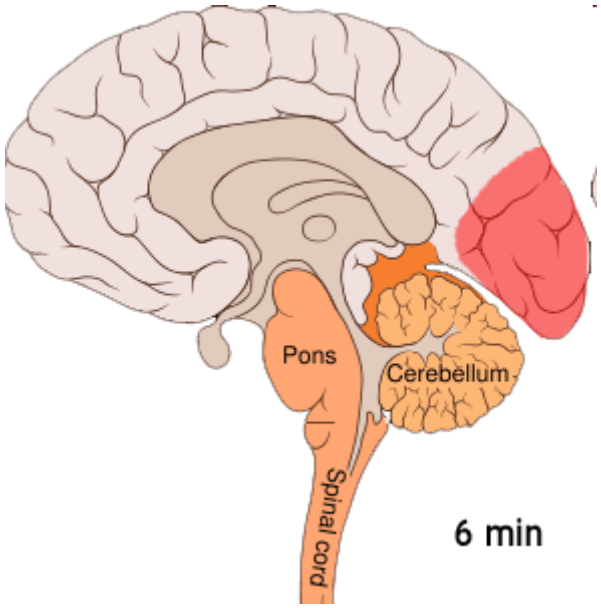
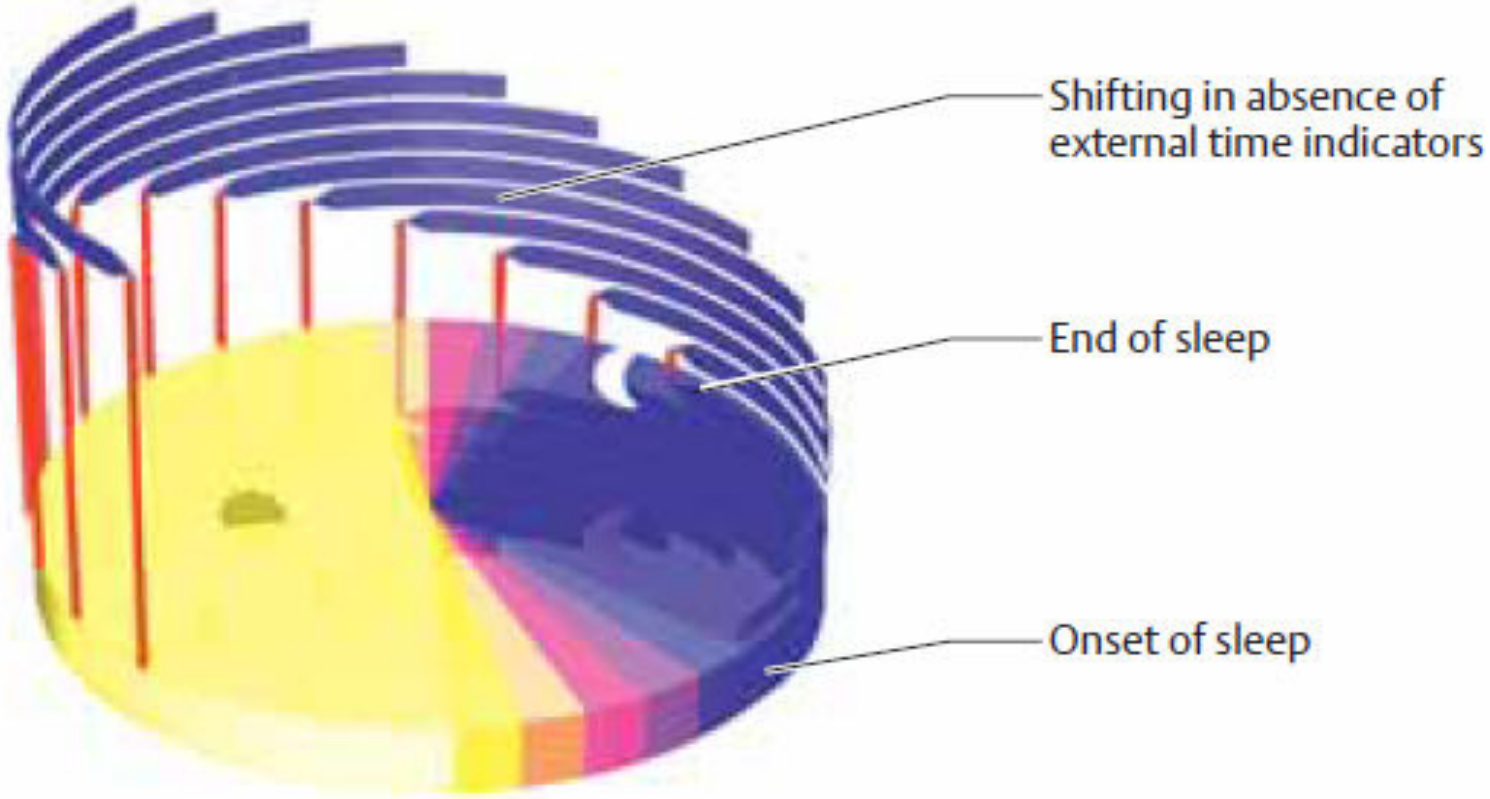


FIGURE 4. Illustration of a scintillating migraine phosphene and its trailing scotoma observed on a *dynamic random-dot noise pattern* (TV screen without program). The scotoma is perceived as a homogeneous neutral grey. Some of the phosphene particles (dotted) appeared in a pure red or green colour, some in deep black (Grüsser & Landis, 1991).

Migraine - scotomas

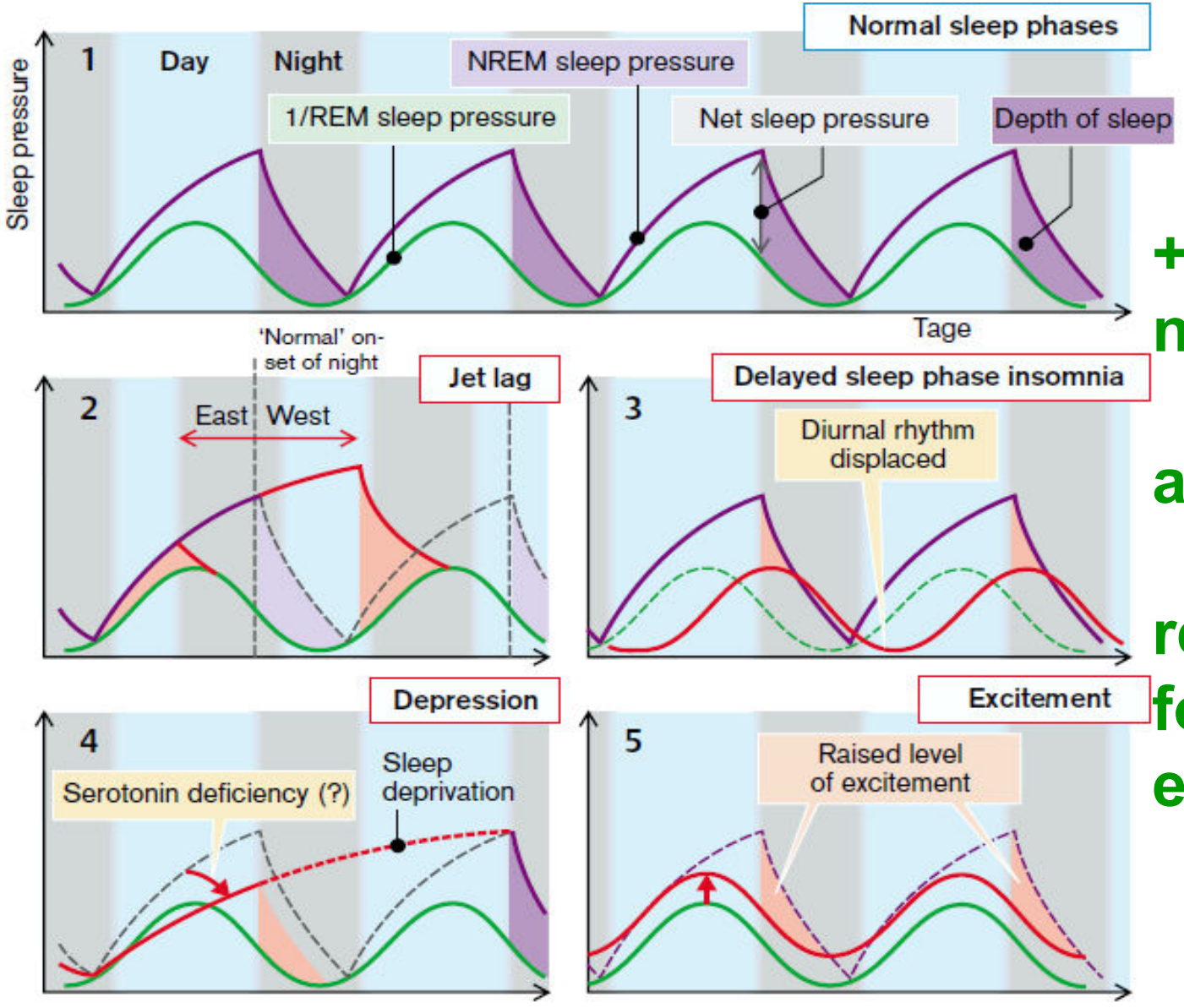


Sleep/ wake cycle



Circadian rhythm

Sleep/ wake cycle



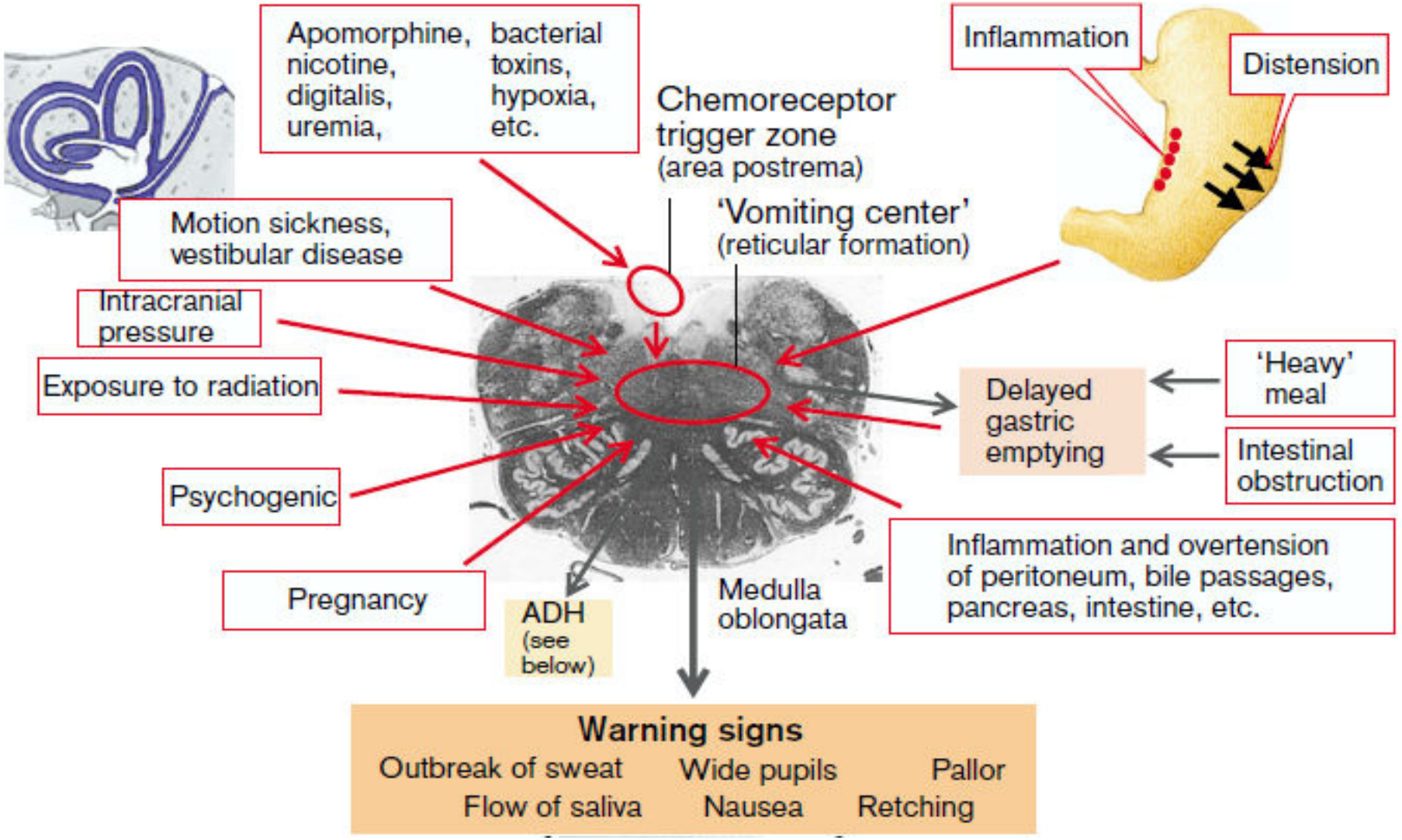
+

narkolepsy

and

reticular formation effects

Vomiting center/ causes of vomiting



Causes of vomiting

1 Intracranial hypertension - irritation

2 Drugs – nicotine, apomorphine, etc

3 Kinetosis

4 Radiation disease

5 Pregnancy

6 Psychogenic

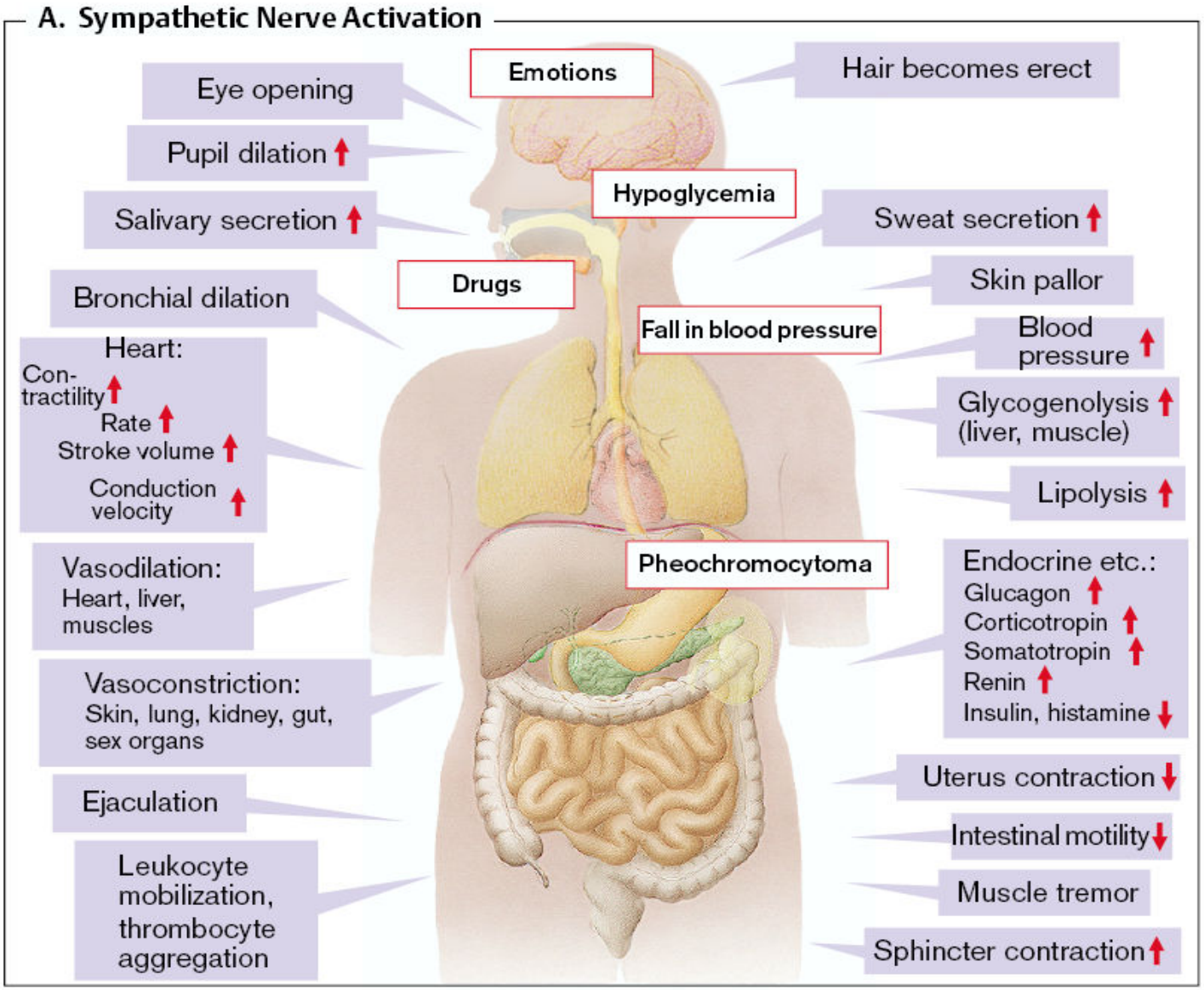
7 Pharyngeal irritation

8 Local gastric irritation – food poisoning

9 Peritoneal irritation, ileus

10 Other internal organs – heart etc

Autonomous nervous system disorders.



B. Loss of Parasympathetic Stimulation

Anticholinergic drugs

- Pupil dilation
- Inhibition of sweating
- Tachycardia
- Decreased motility: Bronchi, gut, bladder (but not sphincters)
- Decreased secretion: Tears, saliva, bronchi, gastrointestinal
- No erection ♂ No vasocongestion ♀