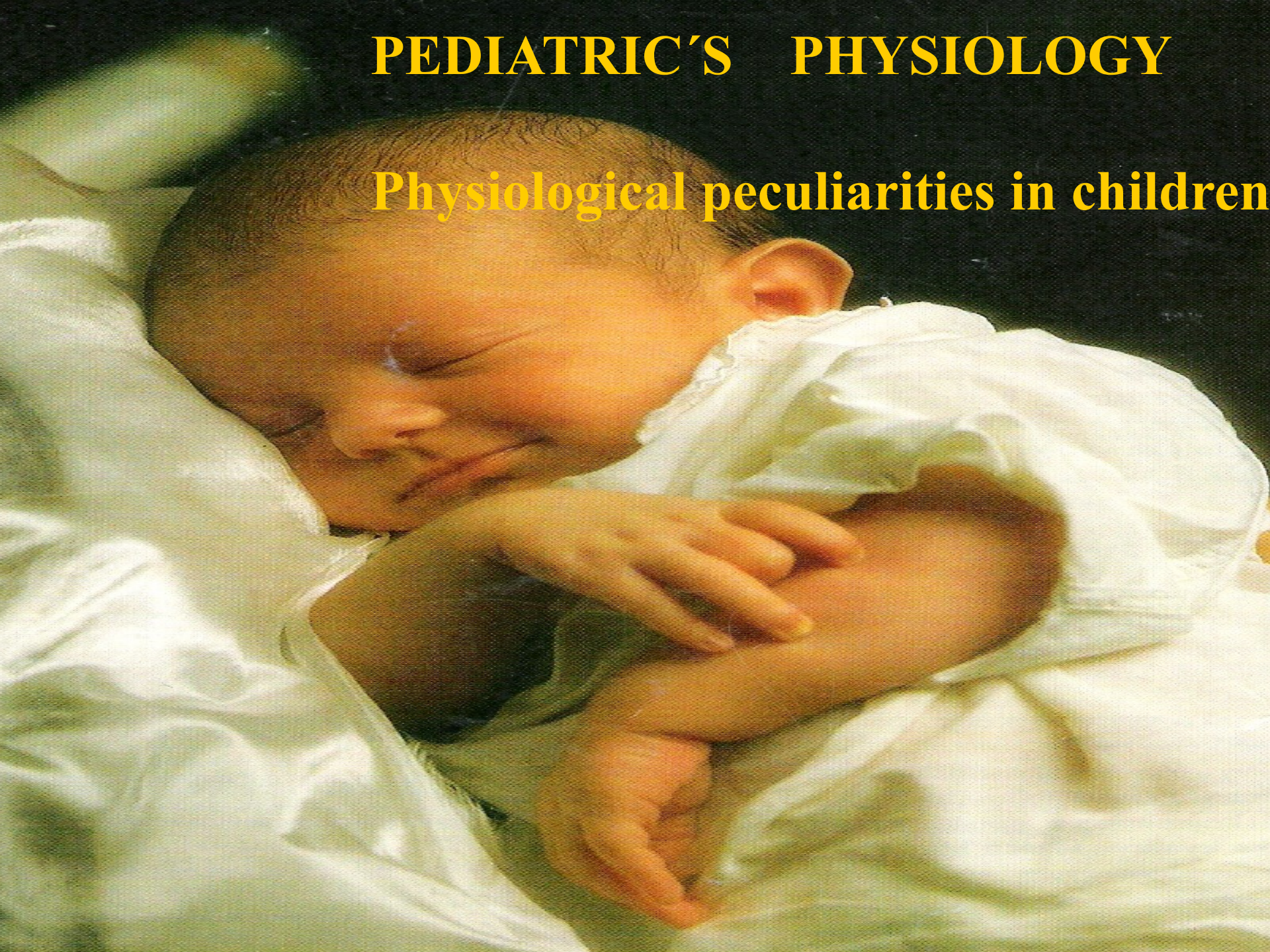
PEDIATRIC´S PHYSIOLOGY

Physiological peculiarities in children



GROWTH PERIODS

- **CHILDREN**

✓Newborn: 0 –28 days after born (1 month)- adaptation period

✓Suckling: 2 – 12 month - infant intensive growth

✓Common term: **infancy**

✓1 – 4 years old

✓(Toddler 1 –3 years old; speech development, development of thinking)

✓Common term: **early childhood**

GROWTH PERIODS

- ✓5 – 12 years old – **late childhood**

- ✓Other special terms:
- ✓Pre-school period 5 – 7 years
- ✓School period – younger, older

GROWTH PERIODS

- **ADOLESCENCE**

✓13 – 20 years old

✓The other special terms:

✓Teenager -19 years

✓Pubertas 11-15 years

WEIGHT

- Birthweight: 2 500 - 3 800 g
- Double birthweight: 4-5 mo
- Triple birthweight: 1yr
- Quadruple birthweight: 2 yr

- Pecularity in newborn: Weight loss in first few days : 5-10% of birthweight
- Return to birthweight: 4 -7 days of age

- AVERADGE weights:

  at birth: 3.5 kg

  at 1 yr: 10 kg

  at 5 yrs: 20 kg

- DAILY weight gain – important for evaluation of nutritional state:

  20-30g for first 3-4 mo

  15-20 g for rest of the first year

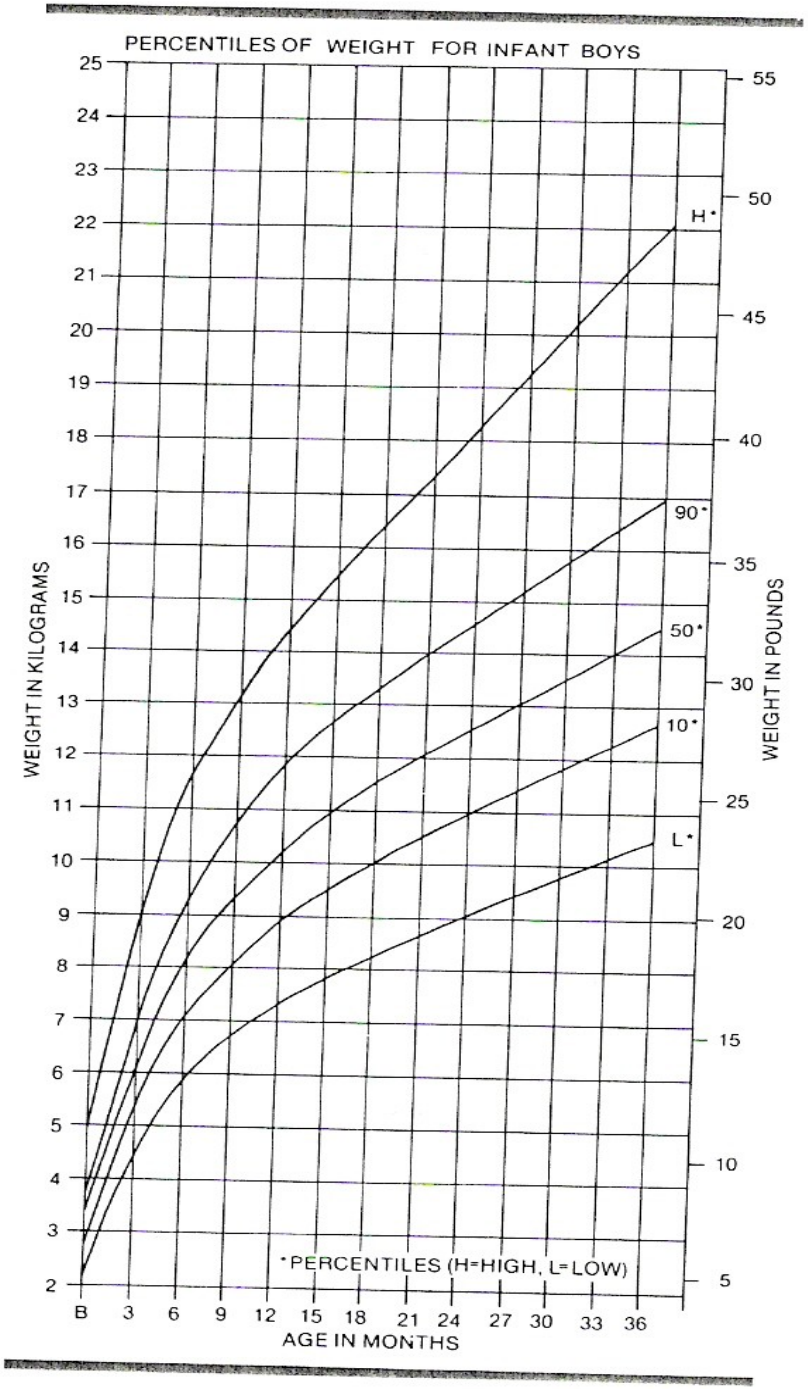


Figure 1–9. Weight by age percentiles for boys, ages birth to 36 mo, including highest and lowest values at each age. (From Pomerance HH: Growth Standards in Children. New York, Harper and Row, 1979, p 25.)

HEIGHT

- AVERADGE length: 20 in (50 cm) at birth
  30 in (75 cm) at 1 yr

  at age 3 yr, the averadge child is 3 ft tall

  at 4 yr, the averadge child is 40 in (100 cm) tall (double birth length)
- Averadge ANNUAL length increase: 2-3 in (5-7 cm) between age 4 yr and puberty

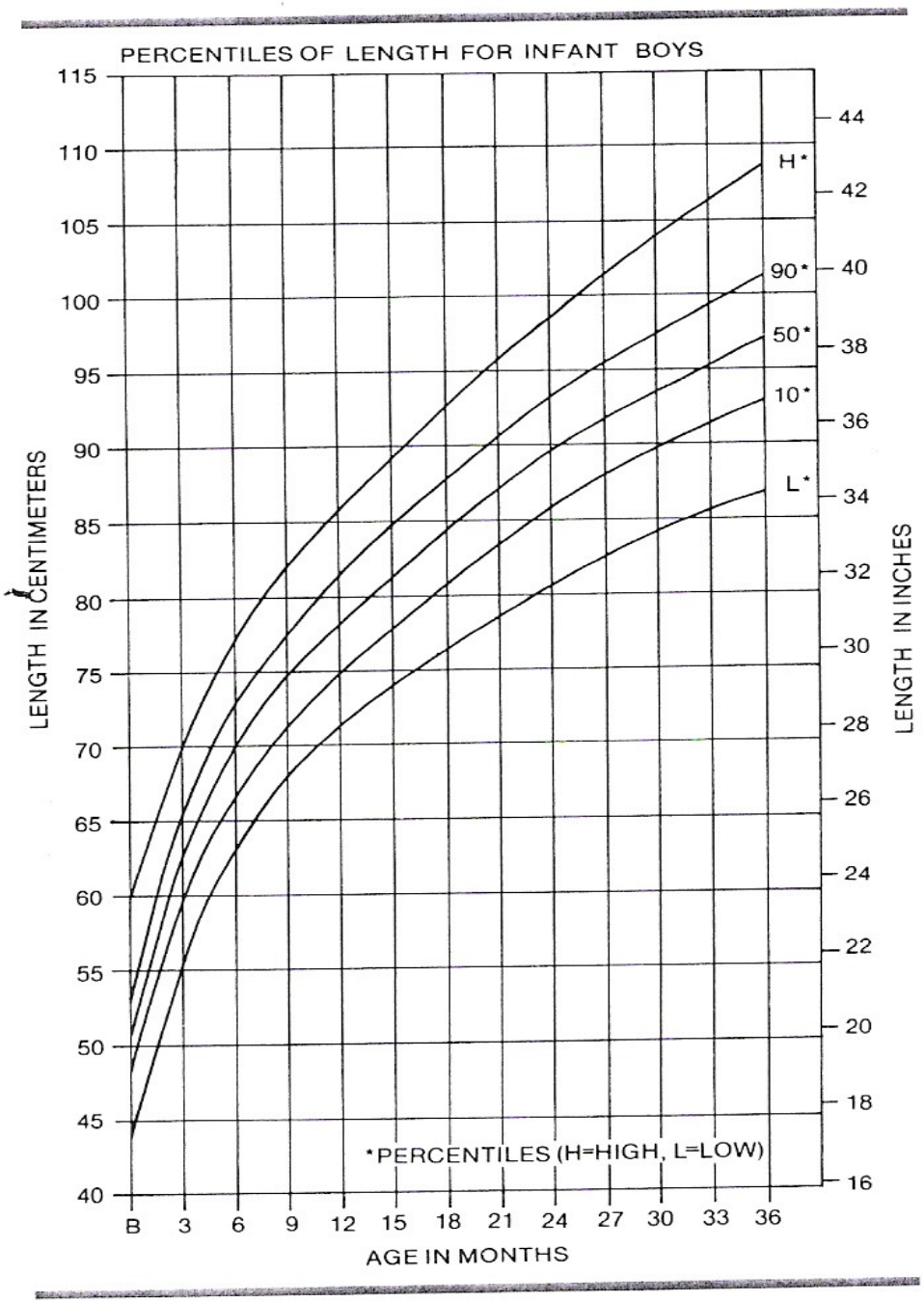


Figure 1–8. Length by age percentiles for boys, ages birth to 36 mo, including highest and lowest values at each age. (From Pomerance HH: Growth Standards in Children. New York, Harper and Row, 1979, p 29.)

HAED CIRCUMFERENCE (HC)

- Averadge HC: 35 cm at birth (13.5 in)
- HC increases:

  1 cm per mo for first year

CHEST CIRCUMFERENCE (ChC)

Averadge 33-34 cm at birth

6th month 43 cm (HC = ChC)

1st year	HC: 46-47 cm	ChC: 48 cm
5th-6th year	HC: 51 cm	ChC: 55 cm
11th year	HC: 52-53 cm	ChC: 63-64cm
14th year	HC: 54 cm	ChC: 68 cm

Newborn according the weeks of gestation and birth weight

- Preterm infant (premature – earlier than 38weeks of gestation)

✓ Low birthweight infants (LBW):

less than 2 500 g

✓ Very low birthweight (VLBW):

less than 1 500 g

- Full-term infant (38 – 40 weeks of gestation)

birthweight 3 000 - 3 500 g, 48-52 cm length, head circumference 35cm

- Ower-term infant (41 – 42 weeks of gestation)

4000 - 6 000g, 53 - 56 cm

A

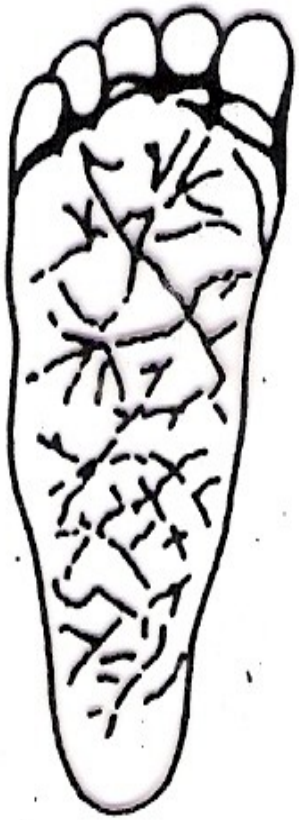
36. týden

36th week

B

38. týden

38th week



C

40. týden

40th week

Gestační věk

week of gestation

(podle Usshera)

The skin

- is covered by white muzzle – ***vernix caseosa***
- after cleansing - deep red - ***erythema neonatorum***

The skin is covered by white muzzle – *vernix caseosa*


19.04.2017 09:10

Examination of newborn at the delivary room

• APGAR score

- acronym or backronym: Appearance, Pulse, Grimace, Activity, Respiration

Signs	Points		
	0	1	2
✓ Heart rate:	0	<100 /min	>100/min
✓ Pulse			
✓ Respiration:	none	weak cry	vigorous cry
✓ Respiration			
✓ Muscle tone	none	hypotonic-hypertonic	limb flexion
✓ Activity			
✓ reflex irritability:	none	some motion	cry, withdrawal
✓ Grimace			
✓ Color of body:	blue	pink body, blue extremities	pink all over
Appearance			


Virginia Apgar
Physician
1909-1974
USA
20

TRANSITION FROM FETAL TO NEONATAL PHYSIOLOGY

- **Specialities of fetal circulation:**

✓ **Placenta**, where deoxygenated blood becomes oxygenated

✓ **1 Umbilical vein** – well-oxygenated blood

✓ **2 Umbilical arteries** – deoxygenated blood

✓ **Foramen ovale**

✓ **Ductus arteriosus Botalli**

✓ **Ductus venosus**

•Changes after birth:

Disconnection of the placental circulation and the beginning of respiration lead to:

•increase pressure in the systemic circulation

•increase in alveolar pO2

•reduction of pulmonary vascular resistance

•increase blood flow to the lungs

•to close the ductus arteriosus (vasoconstriction) and foramen ovale (pressure changes)

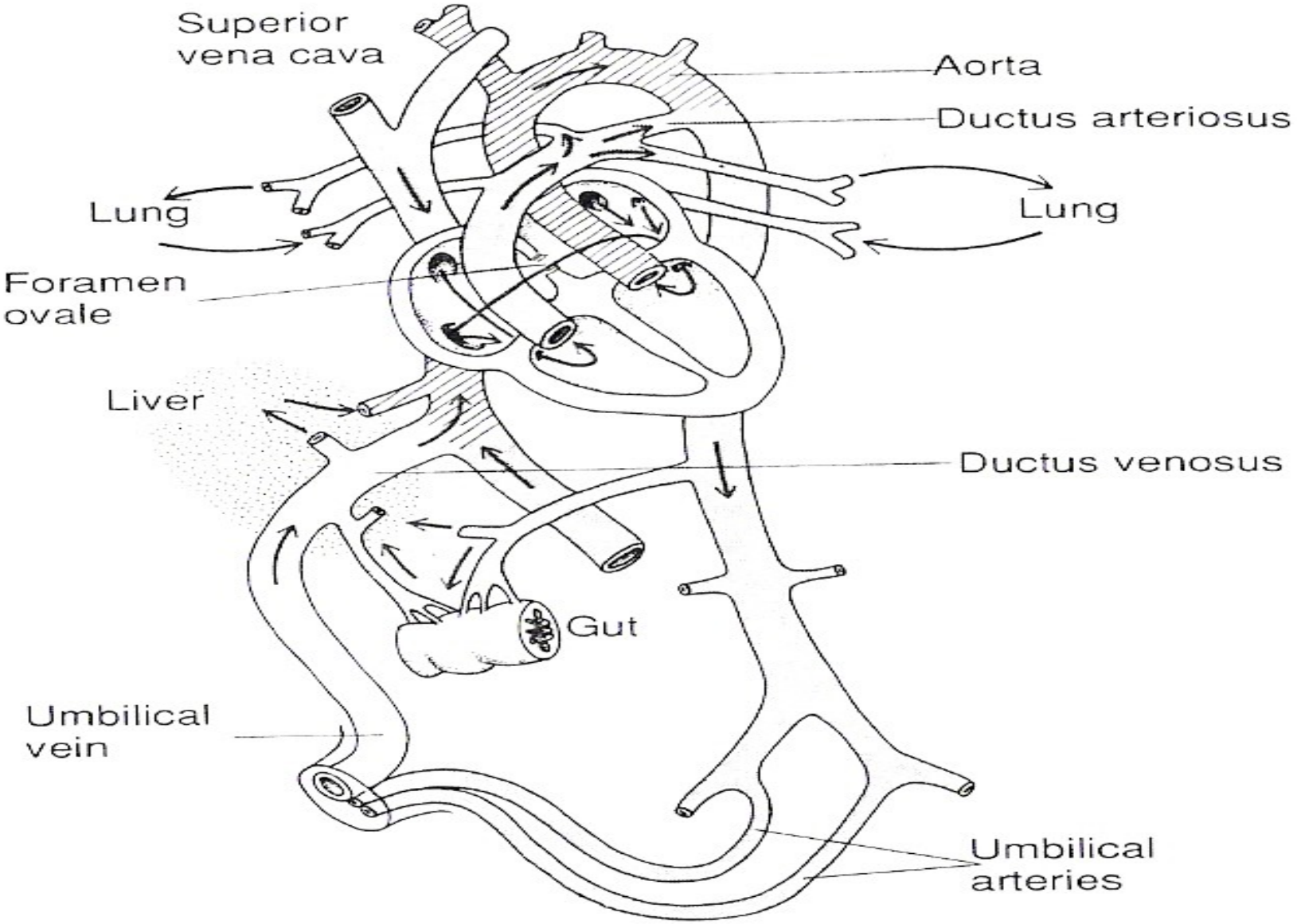


Figure 83–4. Organization of the fetal circulation. (Modified from Arey: Developmental Anatomy. 7th ed. Philadelphia, W. B. Saunders Company, 1974.)

RESPIRATORY SYSTEM

- It plays an important role in postpartum adaptation
- The onset of breathing is ensured by the interplay of a large number of stimuli from many areas
- From the moment of birth to the 1t breath: 20-30s
- Up to 90 second - spontaneous regular breathing
  In the newborn: 40-60 breaths / min, tidal volume 20 ml
- Respiratory movements – started about 20 weeks of gestation - it is only a fluid exchange that fills the bronchoalveolar system: 1-2 ml amount; Ingredients: organic and inorganic substances; pH 6.4; Protein amount 30mg /100 ml; Substances with high surface activity-phospholipids

- Surfactant secretion:

✓ A substance normally secreted into the alveoli that decreases the surface tension of the alveolar fluid, therefore allowing the alveoli to open easily during inspiration

✓ The surfactant secreting cells (the type II alveolar epithelial cells) started secretion about 20 weeks of gestation

- Estimation of pulmonary maturity:

ratio Lecithin/sphingomyelin production 2:1

Dicrease of surfactant in clinical paxis: diagnose **R**espiratory **D**istress **S**yndrome (RDS)

NEONATAL JAUNDICE

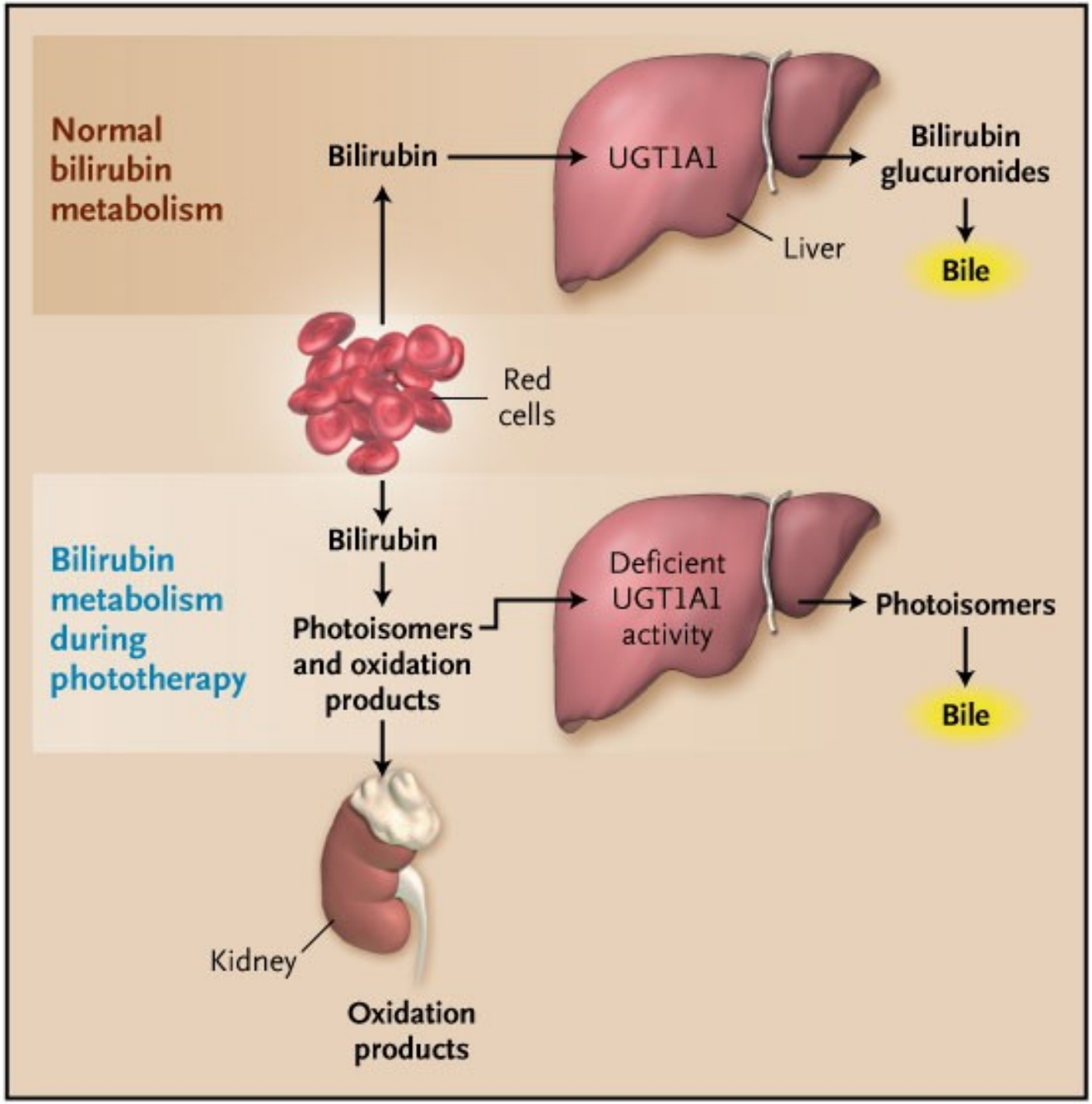
- Bilirubin formed in the fetus can cross the placenta into the mother and be excreted through the liver of the mother

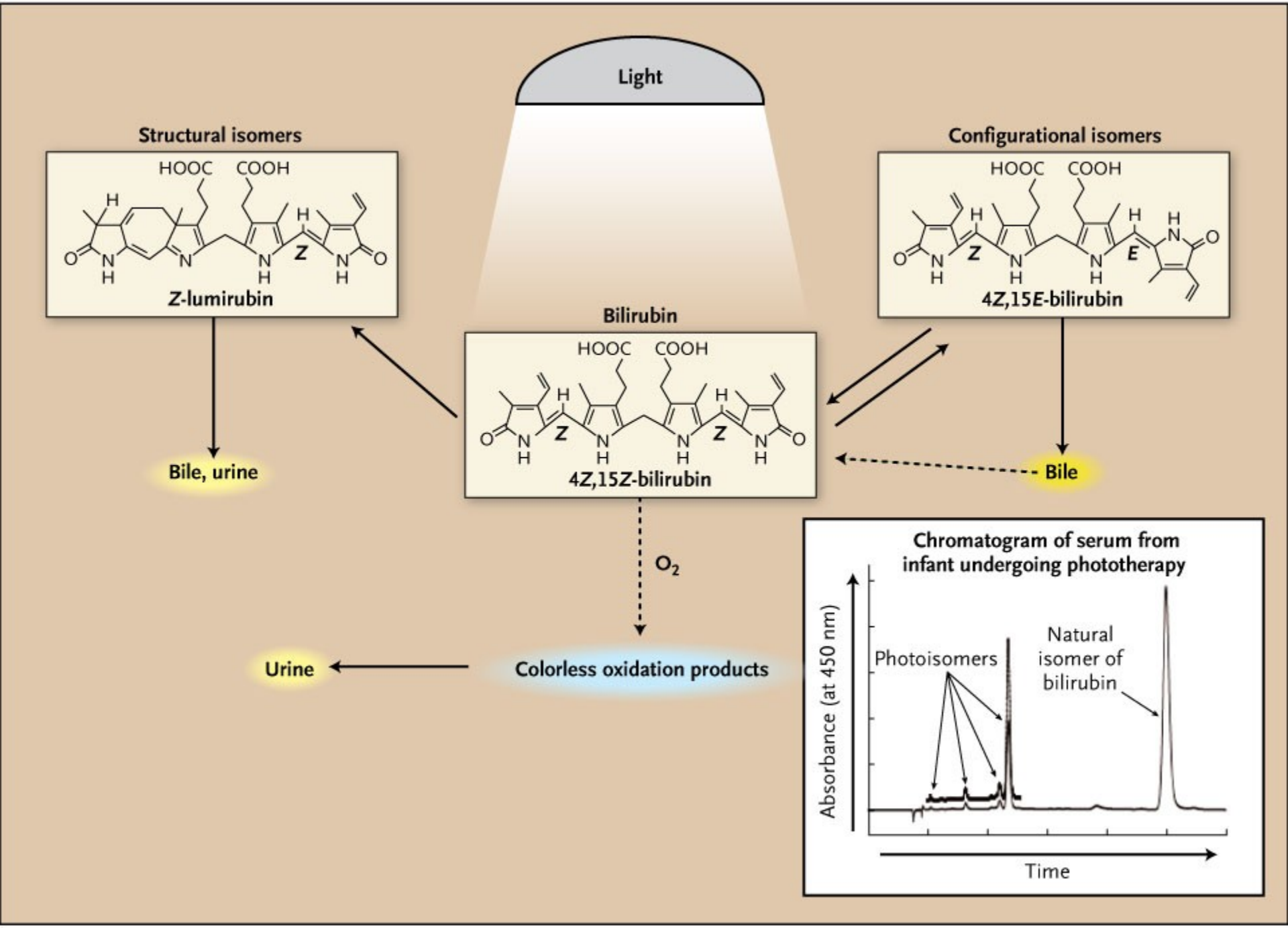
But

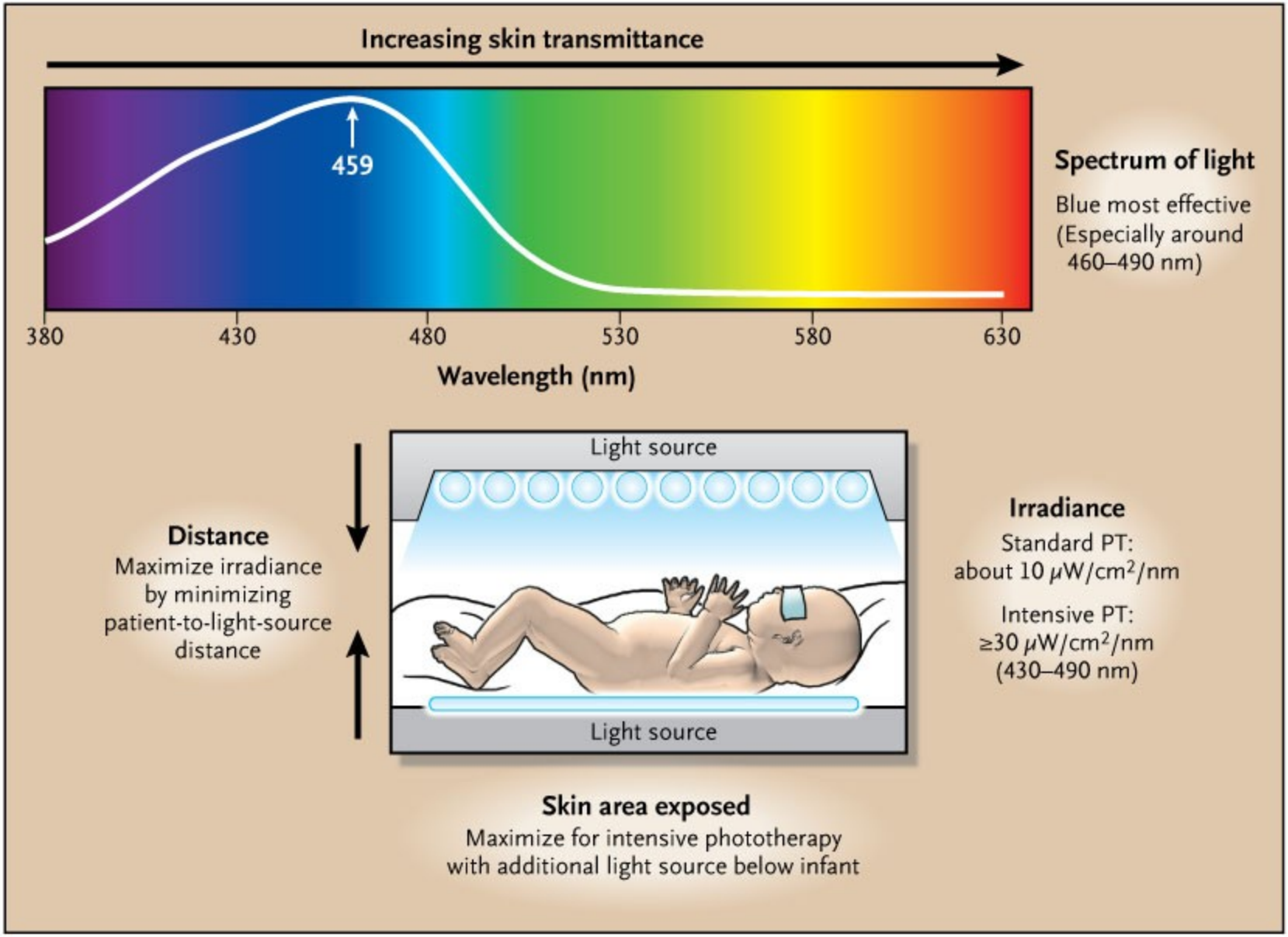
- Immediately after birth the only means for ridding the neonate of bilirubin is through the neonate´s own liver, which for the 1st weeks has poorly functions (without any reserves), and decrease capacity for conjugating system of bilirubin and its excretion into the bile

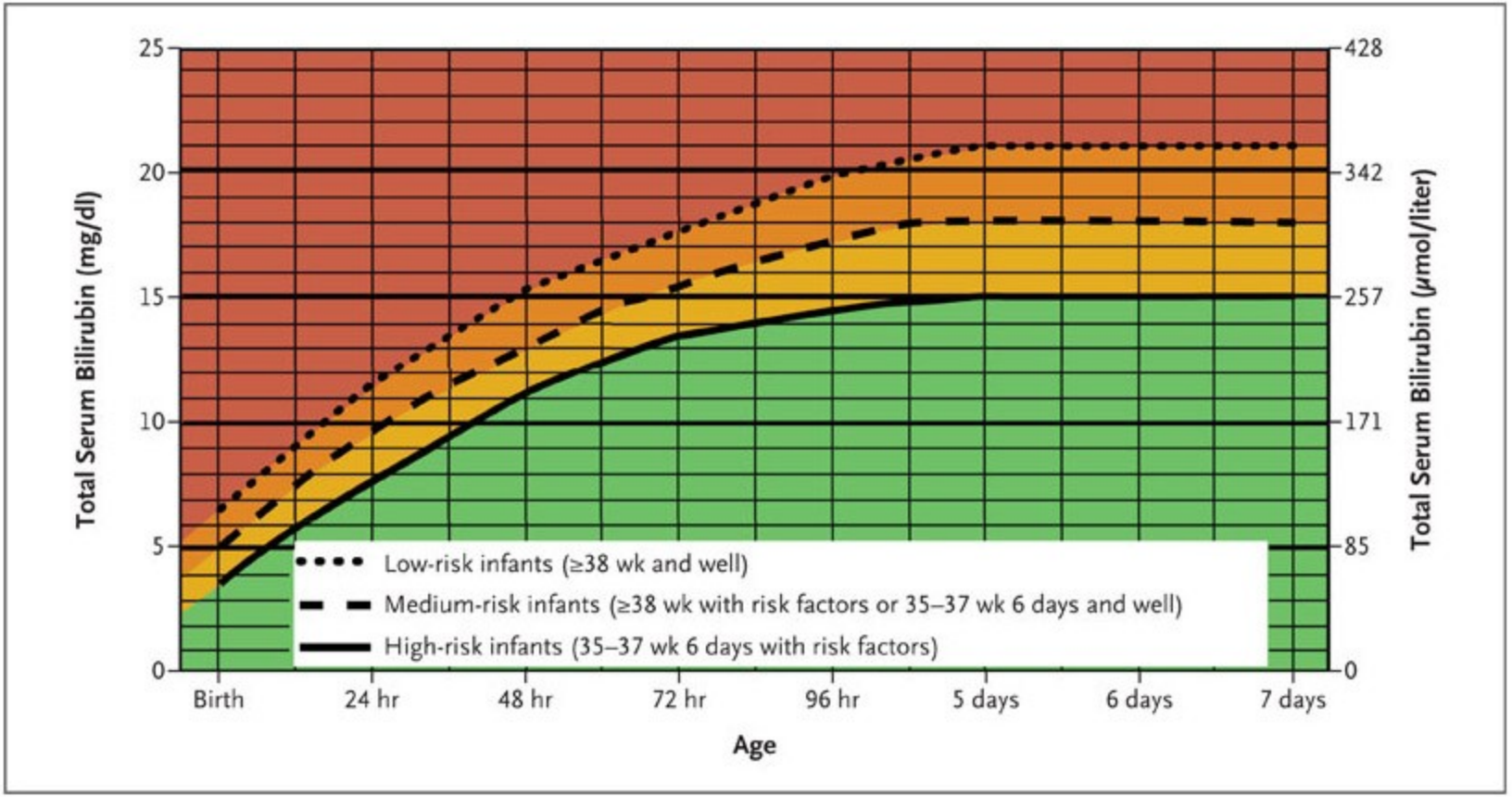
- The plasma bilirubin concentration rises during the first 3 days of life and then gradually falls back to normal as the liver becomes functional

- This condition called physiologic hyperbilirubineamia and it is associated with a mild jaundice of the infant´s skin and especially of the sclerae of its eyes


Normal bilirubin metabolism
Bilirubin
UGT1A1
Bilirubin glucuronides
Liver
Bile
Red cells
Bilirubin metabolism during phototherapy
Bilirubin
Photoisomers and oxidation products
Deficient UGT1A1 activity
Photoisomers
Bile
Kidney
Oxidation products


Light
Structural isomers
HOOC COOH
Z-lumirubin
Configurational isomers
HOOC COOH
4Z,15E-bilirubin
Bilirubin
HOOC COOH
4Z,15Z-bilirubin
Bile, urine
Bile
O2
Urine
Colorless oxidation products
Chromatogram of serum from infant undergoing phototherapy
Absorbance (at 450 nm)
Photoisomers
Natural isomer of bilirubin
Time


Increasing skin transmittance
459
380
430
480
530
580
630
Wavelength (nm)
Spectrum of light
Blue most effective
(Especially around
460–490 nm)
Light source
Light source
Distance
Maximize irradiance
by minimizing
patient-to-light-source
distance
Irradiance
Standard PT:
about 10 μW/cm²/nm
Intensive PT:
≥30 μW/cm²/nm
(430–490 nm)
Skin area exposed
Maximize for intensive phototherapy
with additional light source below infant


Total Serum Bilirubin (mg/dl)
25
20
15
10
5
0
428
342
257
171
85
0
Total Serum Bilirubin (μmol/liter)
Low-risk infants (≥38 wk and well)
Medium-risk infants (≥38 wk with risk factors or 35–37 wk 6 days and well)
High-risk infants (35–37 wk 6 days with risk factors)
Birth
24 hr
48 hr
72 hr
96 hr
5 days
6 days
7 days
Age

TEMPERATURE

- In utero thermoregulation of the fetus is performed by the placenta, which is as an efficient heat exchanger
- Fetal temperature is higher than the mother´s temperature: about 38.5 °C
- After birth, the newborn infant begins life covered by amniotic fluid and situated in a cold environment: 20-25 °C
- An infant´s skin temperature may fall 0.3 °C/min and the core temperature may decline 0.1 °C/min in the delivery room

- Because the body surface area is large in relation to body mass, heat is readily lost from the body
- The ideal environmental temperature is called as **the neutral thermal environment**: the ambient temperature resulting in the lowest rate of heat production and the lowest consumption of oxygen by the infants while maintaining normal body temperature
- 1 hour after birth: 33-34 °C
- 1 day after birth: 31-33 °C
- 1 weeks after birth: 27-33 °C

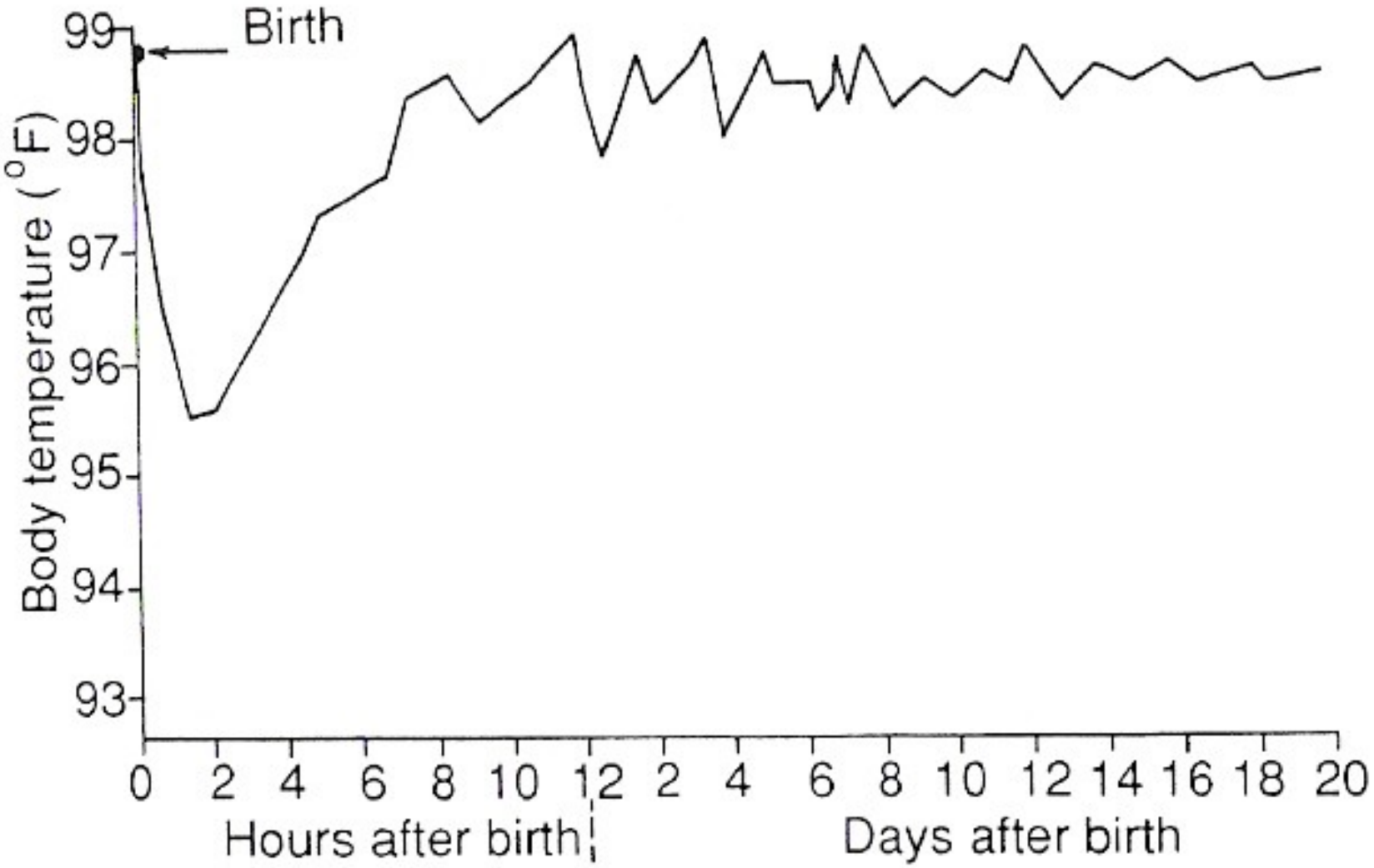
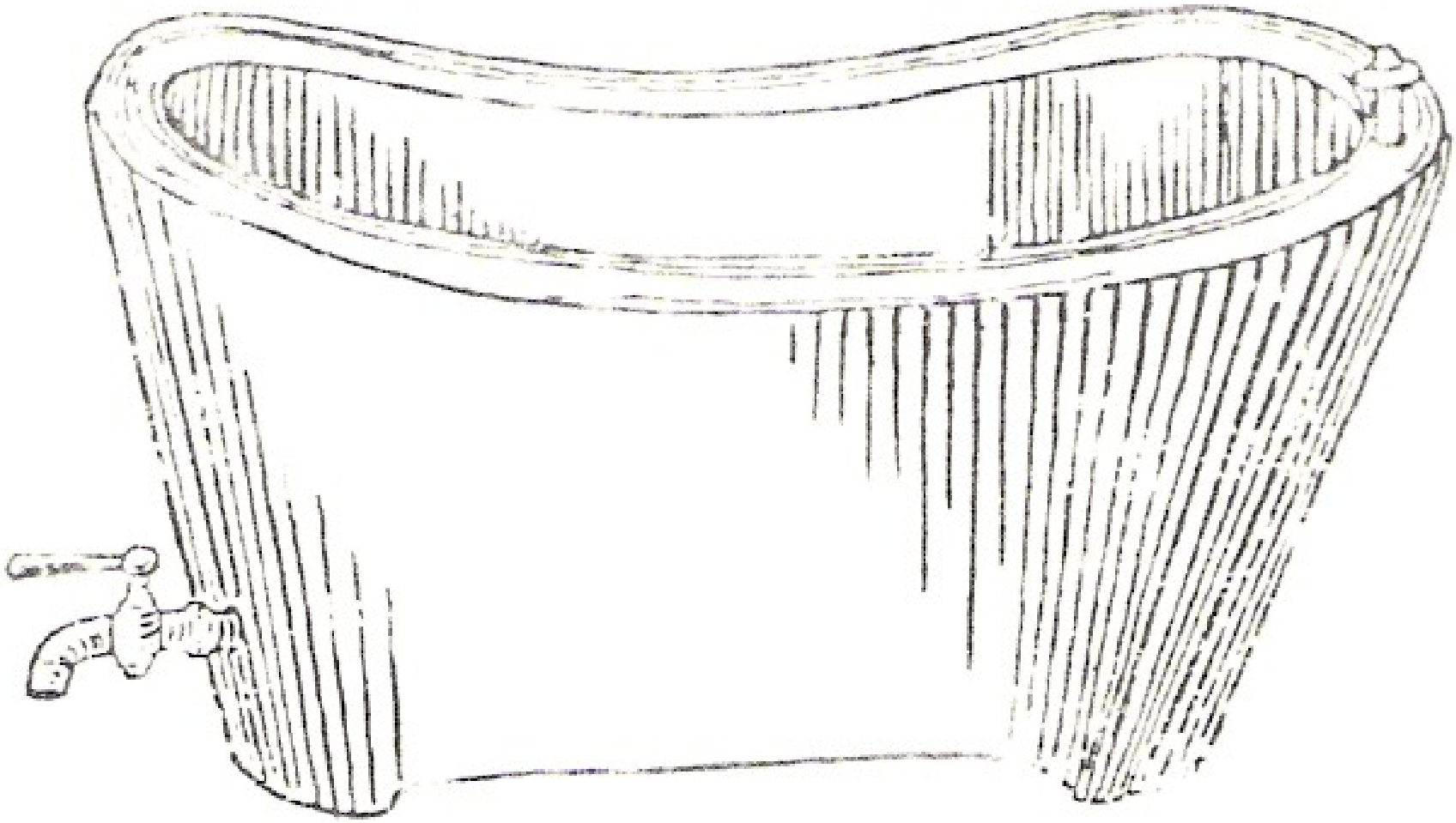
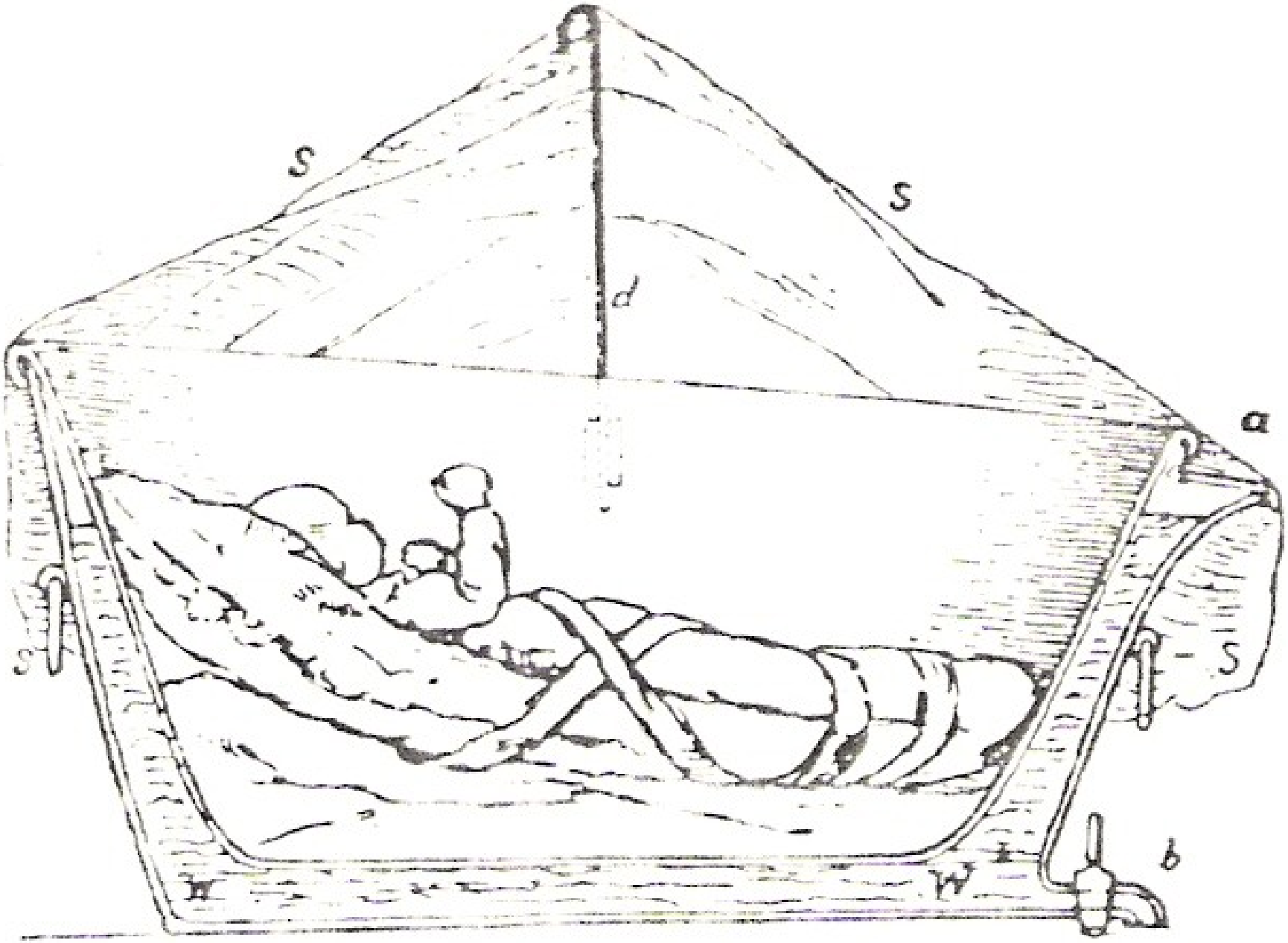
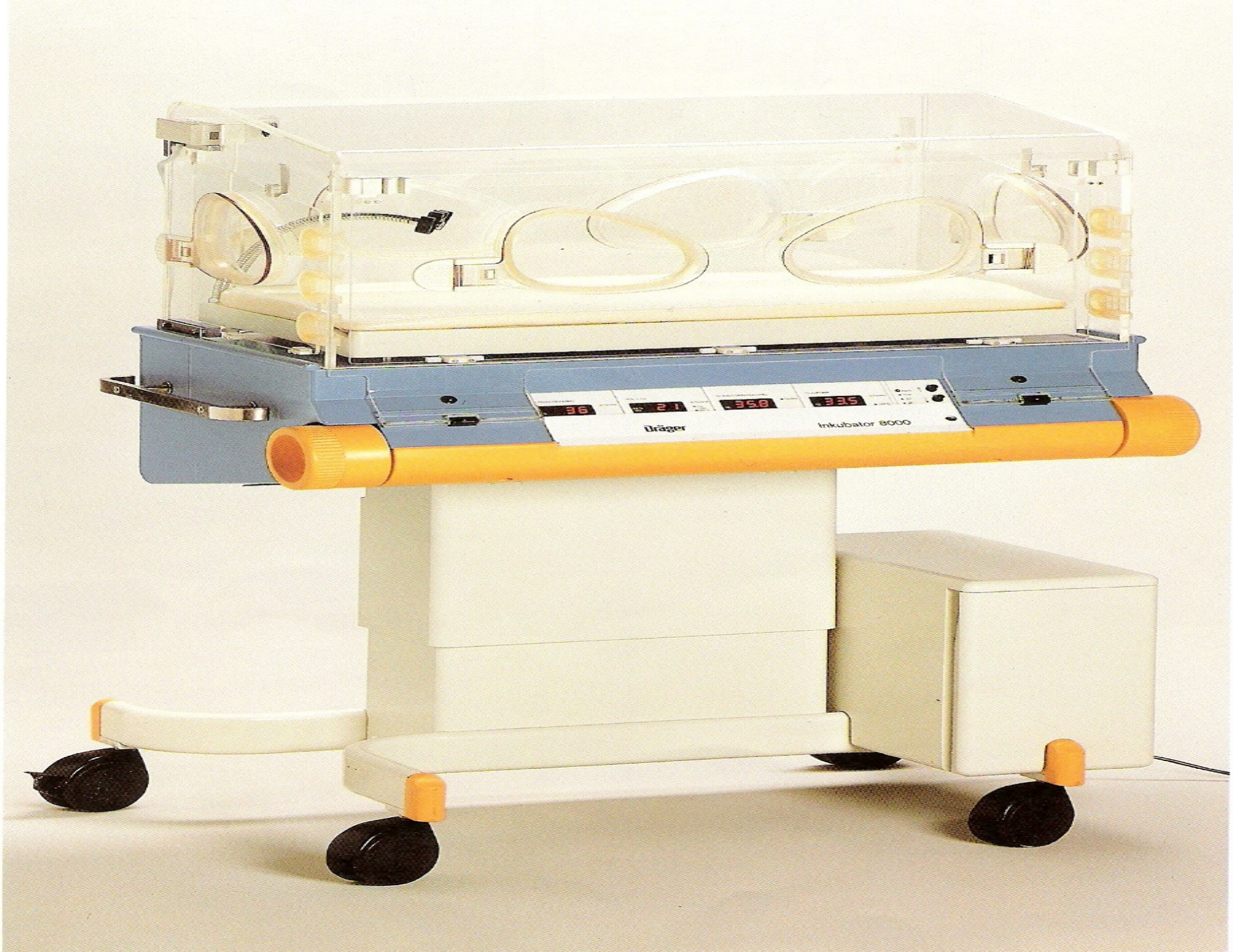


Figure 83–7. Fall in body temperature of the neonate immediately after birth, and instability of body temperature during the first few days of life.





Empress Catherine the Great, Russia, 18th century
survival against the russian winter


36
21
35.8
33.5
Dräger
Inkubator 8000

Immune system

- **a main prenatal imunoglobulin = IgG:**
  - passes through the placenta
  - At the birth – the same level as in mother
  - at birth is the same concentration as in the mother's body
  - gradually decreasing its concentration
  - in 3rd to 10th week reached the lowest values then again levels increase

- **IgM** forms newborns aged 1-2 weeks

- **IgA** occurs at the age of one month, then the concentration slowly increases

  (IgA is rich colostrum and breast milk)

BLOOD - composition

- **After birth:**

✓ **Erythrocytes = 5-6 x 10^{12}/l**

✓ **Leukocytes = 20-22 x 10^{9} /l**

✓ **Hemoglobin = 190 g/l**

- **At 3 month of live:**

✓ **Erythrocytes = 4 x 10^{12}/l**

✓ **Leukocytes = 10.5 x 10^{9}/l**

✓ **Hemoglobin = 110 g/l**

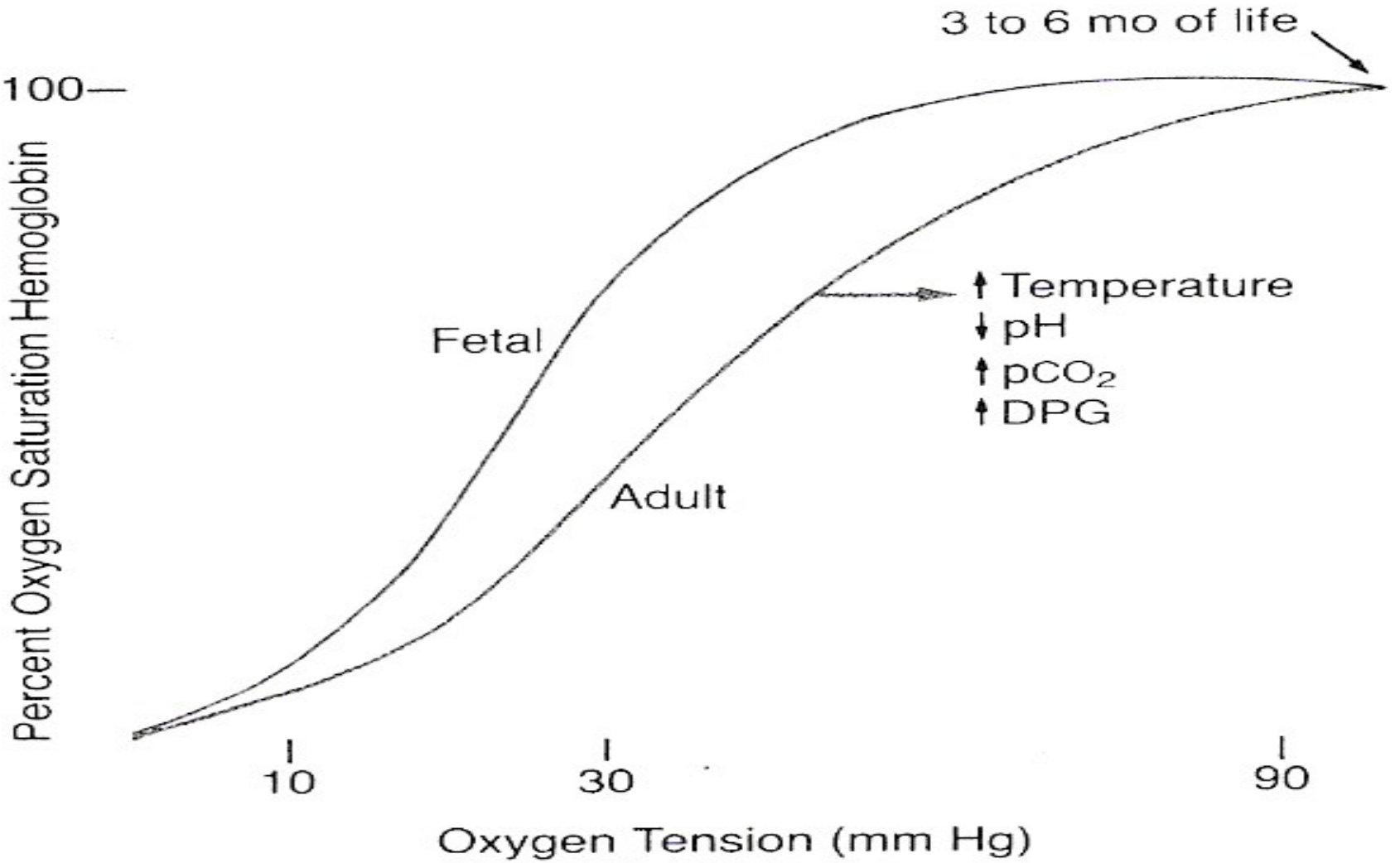


Figure 5–2. Hemoglobin-oxygen dissociation curves. The position of the adult curve depends on the binding of adult hemoglobin to 2,3-diphosphoglycerate (DPG), temperature, carbon dioxide tension (pCO_2), and hydrogen ion concentration (pH).

CARDIOVASCULAR SYSTEM

Heart rate according age

• Newborn	135-140 beat per minute
• 6 month	130-135
• 1 year	120-125
• 2 years	110-115
• 5 years	98-100
• 8 years	80-85
• 15 years	70-76

Elektrocardiography

- More difficult evaluation than in adult
- The ECG curve is changing with respect to:
  - Ratio between right ventricule muscle/left ventricule muscle
  - Spred of activation from atrium to ventricule myocardium
  - repolarization

Evaluation of ECG curve in children is nescesary made with respect to anamnesis, clinical state and laboratory view

- **Generally accepted:**
  - In newborn – predominance of the right ventricule
  - To 3 month after birth – increase of left forces
  - At 2 years – right and left ventricule in equilibrium
  - 3 years to adult – prevalence (superiority) of left ventricule

Blood pressure

- Immediately after birth – high blood pressure:
  - Stress after delivery, increase concentration of catecholamine and cortizol
- After 1st day …….. 70/50 mmHg:
  - Open of pulmonary and intestine circulation
- During pubertas:
  - Development of regulatory mechanism
  - Stimulation of external world

- Newborn **80/46 mmHg** 10.6/6.1 kPa
- 3 years **100/67** 13.3/8.9
- 10-11 years **111/58** 14.8/7.7
- 13-14 years **118/60** 15.7/8.0

The size of cuffs

Body weight	age	size of cuff
1 500 g	*	2.5 cm
5 kg	3 month	4.5 cm
10 kg	15 month	6 cm
30 kg	9 year	7.5 cm
30 kg and more	10 year and more	12 cm

GIT and NUTRITION

- In general, the ability of the neonate to digest, absorb, and metabolize foods is not different that of the older child, with the following 3 exceptions:

✓ 1. Secretion of pancretic amylase is deficient

✓ 2. Absorption of fats from the gastrointestinal tract is somewhat less than that in the older child (milk with a high fat content - such as cow´s milk, is inadequately absorbed)

✓ 3. The liver function during at least the 1st week of life, the glucose concentration in the blood is unstable and low

GIT

- **Intrauterine:** motor, secretory and resorption activity of the GIT is low
- **At birth:**
- digestive enzymes for breast milk prepared
- the structure of the mucosa is no different from that of an adult
- weaker layer of muscles - susceptibility to meteorism
- content of meconium in the intestine - it is possible to excrete it by the 4th day of life

- Decreased control of intestinal motility by the enteral nervous system with easy return of food to the oral cavity, imperfect sucking and swallowing, slower gastric emptying - frequent blinking and vomiting

THEORY of AGE

Elderly period

- **Earlier senior: 65 - 75 years old**
- **Middle senior: 75 - 85 years old**
- **Late senior: above 85 years old**

- **The „AGING“ is programming biological process**

Theory of „aging“

- **„Free radicals“**

– primary reason for aging is: damages of macromolecules and structures of cells by biochemistry reactions of free oxygen radicals

(oxygen free radicals damaging our bodies are „taxes“ that people breathe oxygen on the Earth)

- **Neuroendocrine theory**

- This theory is based on the fact, that the secretion of hormone melatonin is reduce with age (as „youth hormone“; pineal gland – coordinates of circadian rhythms)

- **Gene theory**
- Increase a lot of mutations in the cells during all of the lifetime, the mutations are a primary cause of the aging
- Theory of programming of aging is based on the idea that the function of genes is reduced in time (e.g. Apoptosis – programming death of the cells)
- Theory based on the hypothesis that exist „any genetic programme“ (Hayflick 1985 – observing the families with longevity)

The symptoms of aging

- **Reduction of <u>function</u> of all organ systems:**
- | loco-motor function – as general and final, decreas of forces of sceletal muscles
- reduction of capacity of the lungs, cardiac output, cardiac reserve, function of excretory system, liver, metabolism
- reduction of number of neurons in the brain (central nervous system)

- **The other symptoms:**
- Changes in places of fat deposits
- Changes of the skin hair
- Changes in the memory – main in the short-term memory
- Changes of the behavior – non-tolerance, depression

„Everyone is old, depending on how he/she feels to be old“