

PHYSIOLOGY OF THE NEWBORN

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หน่วยทารกแรกเกิด ภาควิชากุมารเวชศาสตร์

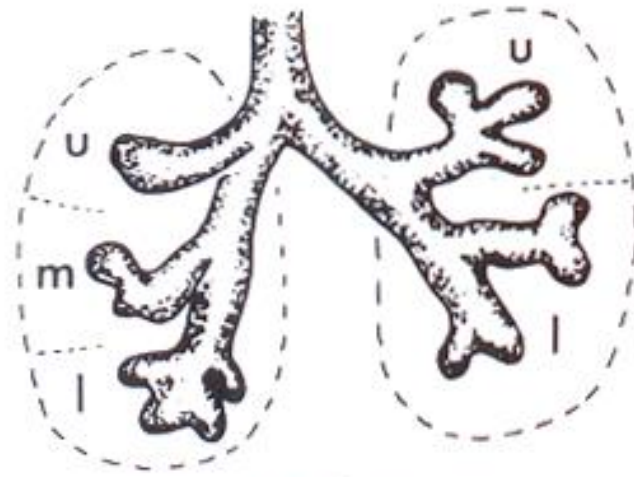
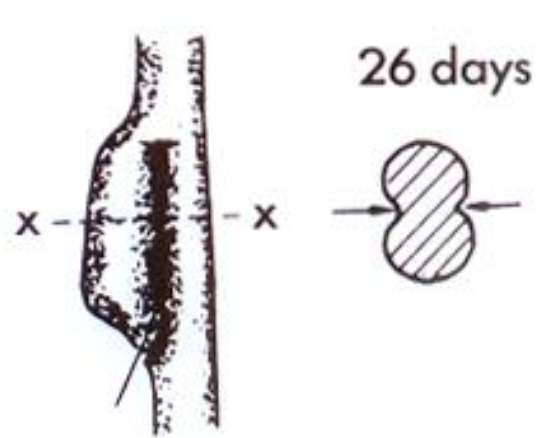
คณะแพทยศาสตร์ มหาวิทยาลัยขอนแก่น



RESPIRATORY SYSTEM

Lung Development

- 1. Embryonic Period : 4 to 6 weeks**
- 2. Glandular Period : 7 to 16 weeks**
- 3. Canalicular Period : 17 to 27 weeks**
- 4. Saccular Period : 28 to 35 weeks**
- 5. Alveolar Period : 36 weeks to 3 years**



Surfactant

Composition

70- 80% **phospholipids**

10% **protein**

10% **neutral lipids**

primarily cholesterol

Surfactant

Composition : Phospholipids

phosphatidylcholine (lecithin)

phosphatidylglycerol

phosphatidylinositol

phosphatidylethanolamine

Surfactant

Functions

Stabilize the lung during deflation

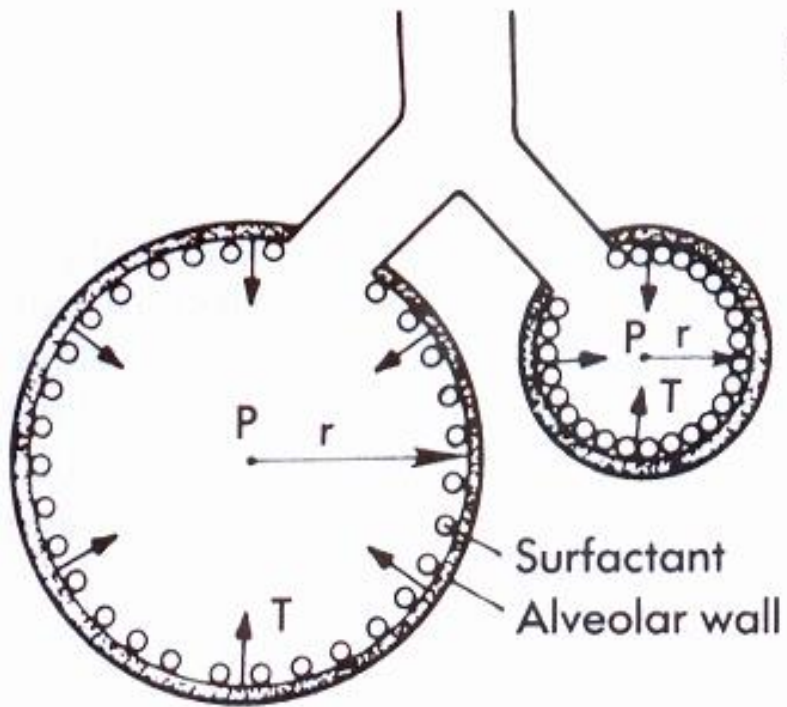
Prevent high surface tension

Protect the lung against epithelial and endothelial injury

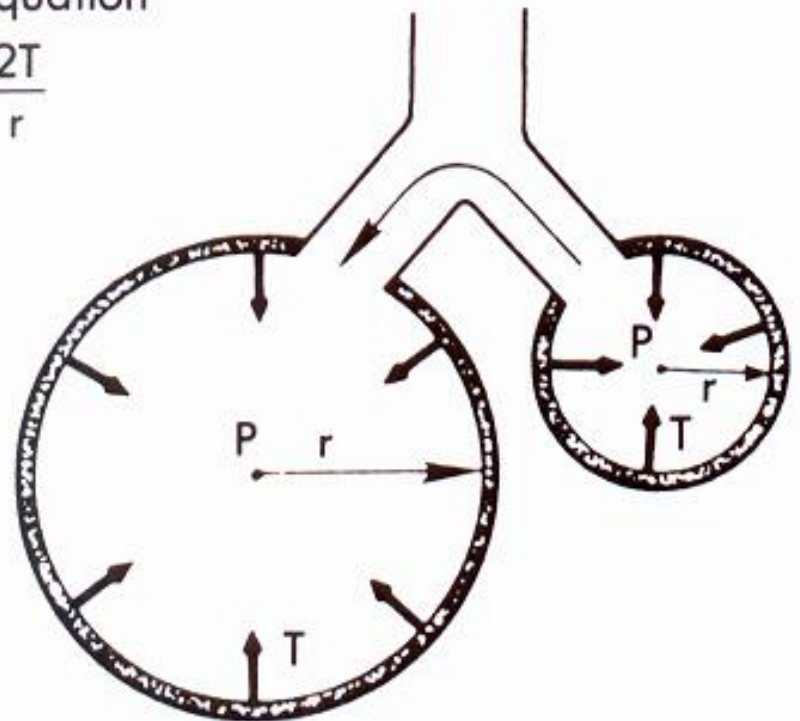
Provide a defense against infection

Laplace equation

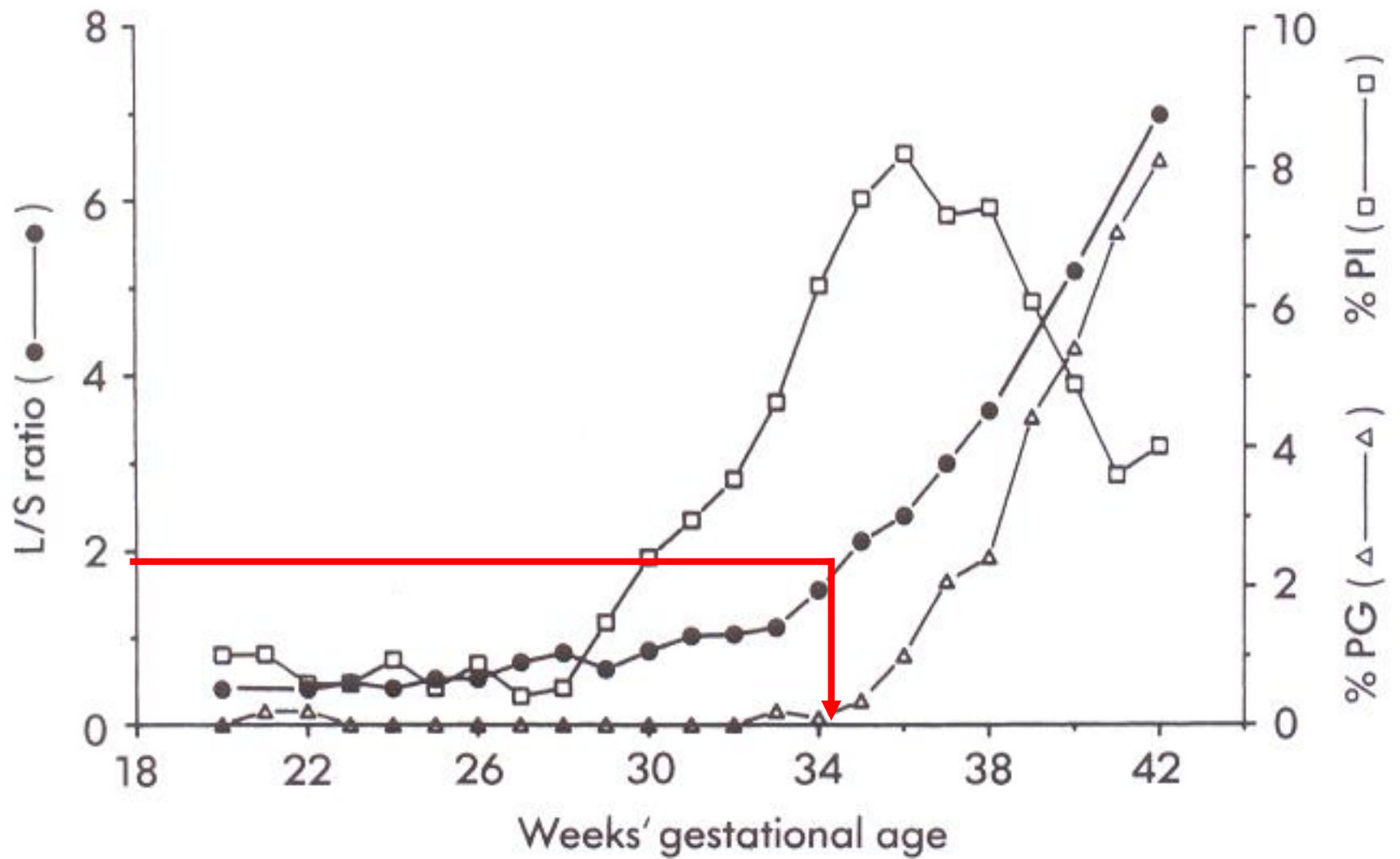
$$p = \frac{2T}{r}$$



+ Surfactant



- Surfactant



Surfactant deficiency

Atelectasis

V/Q mismatch

Hypoventilation

Hypoxemia & hypercarbia

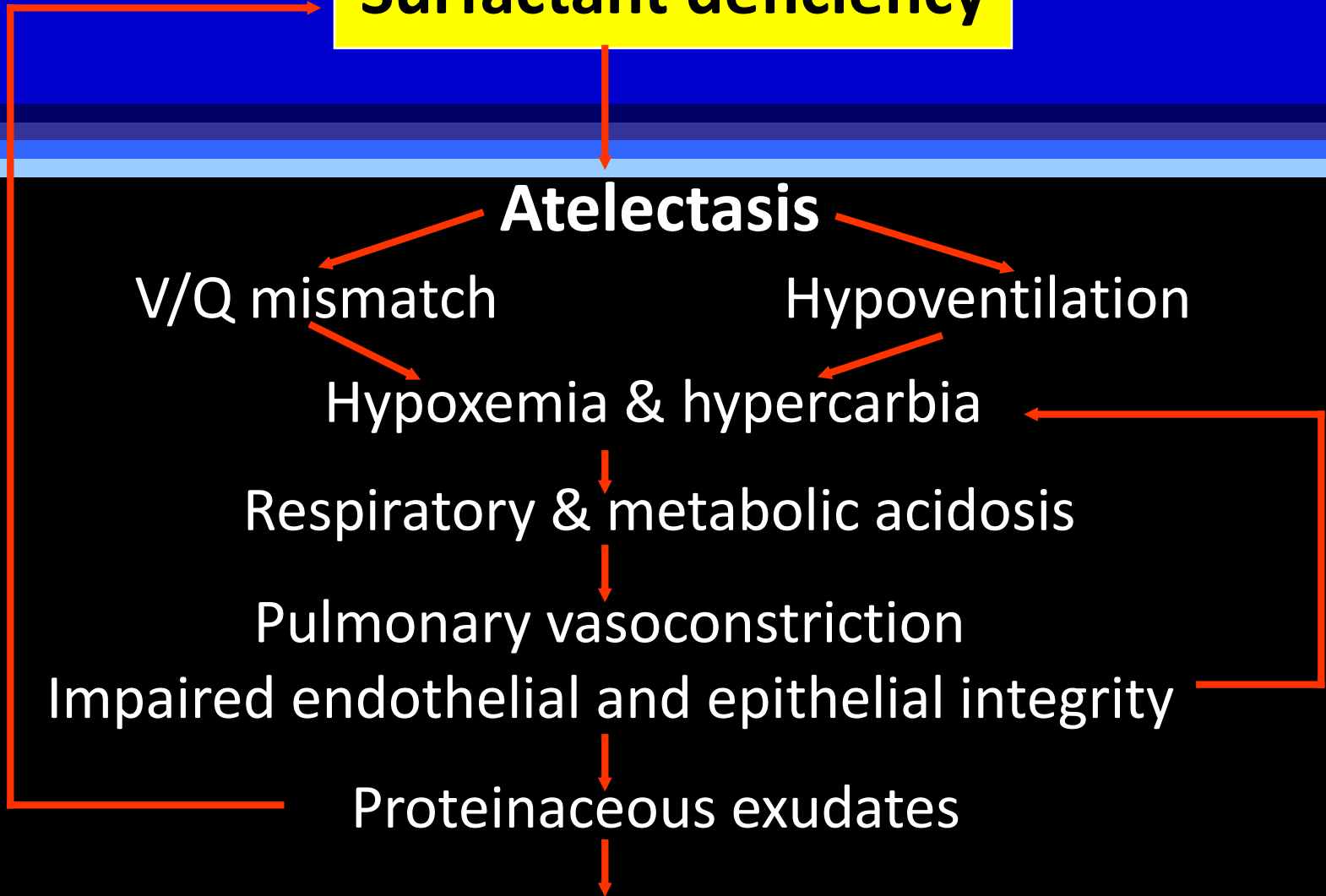
Respiratory & metabolic acidosis

Pulmonary vasoconstriction

Impaired endothelial and epithelial integrity

Proteinaceous exudates

Respiratory Distress Syndrome





Lung Fluid

Production 4-6 ml/kg/hr

Ultrafiltration of plasma

Active pumping of chloride from
interstitium into air space

Total 20-30 ml/kg = FRC

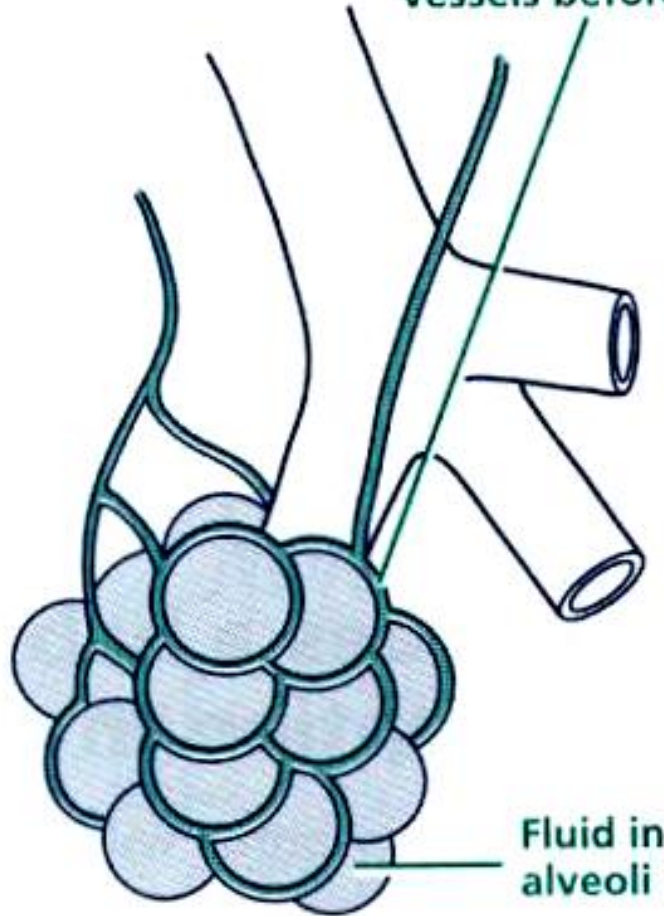
Composition of Lung Fluid

Component	Lung Liquid	Plasma	Amniotic Fluid
Sodium (mEq/L)	150	150	113
Potassium (mEq/L)	6.3	4.8	7.6
Chloride (mEq/L)	157	107	87
Bicarbonate (mEq/L)	3	24	19
pH	6.27	7.37	7.02
Protein (g/dL)	0.03	4.09	0.10

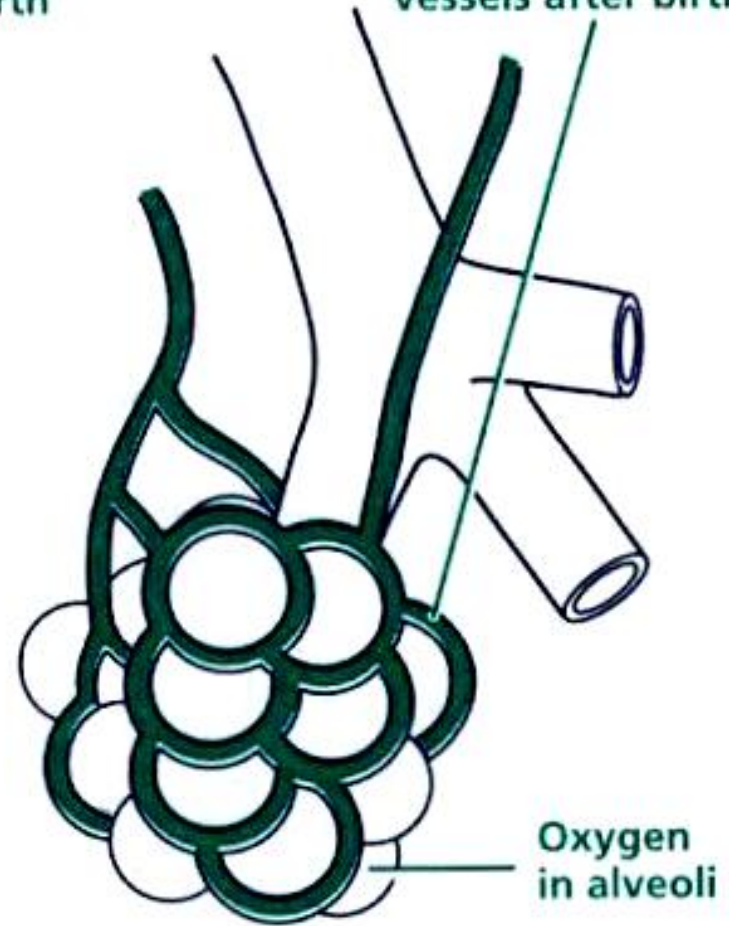
Process of Clearing Lung Fluid

- * Begins 2 to 3 days prior to birth**
- * Decrease rate of secretion**
- * Clearance occurs during labor**
- * Change from chloride - secreting to sodium absorbing membrane**
- * Lymphatics & pulmonary vessels drainage**

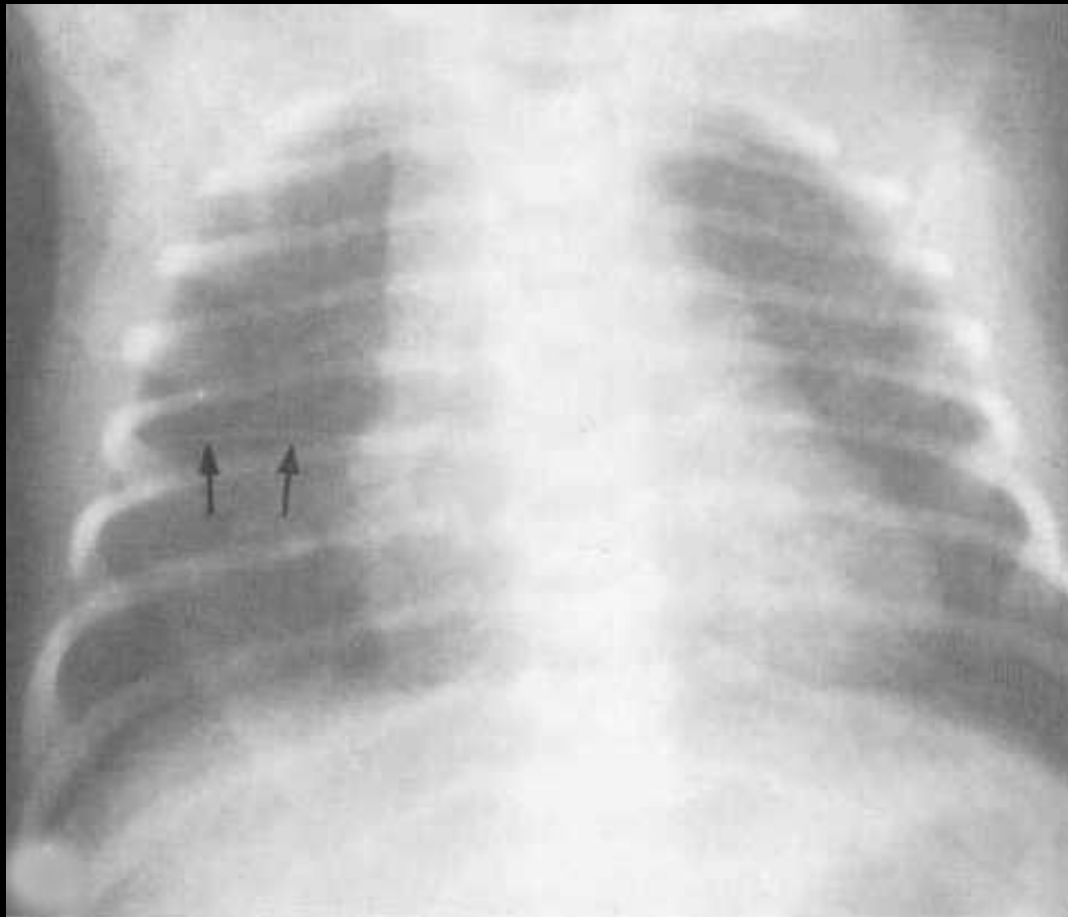
Constricted blood
vessels before birth



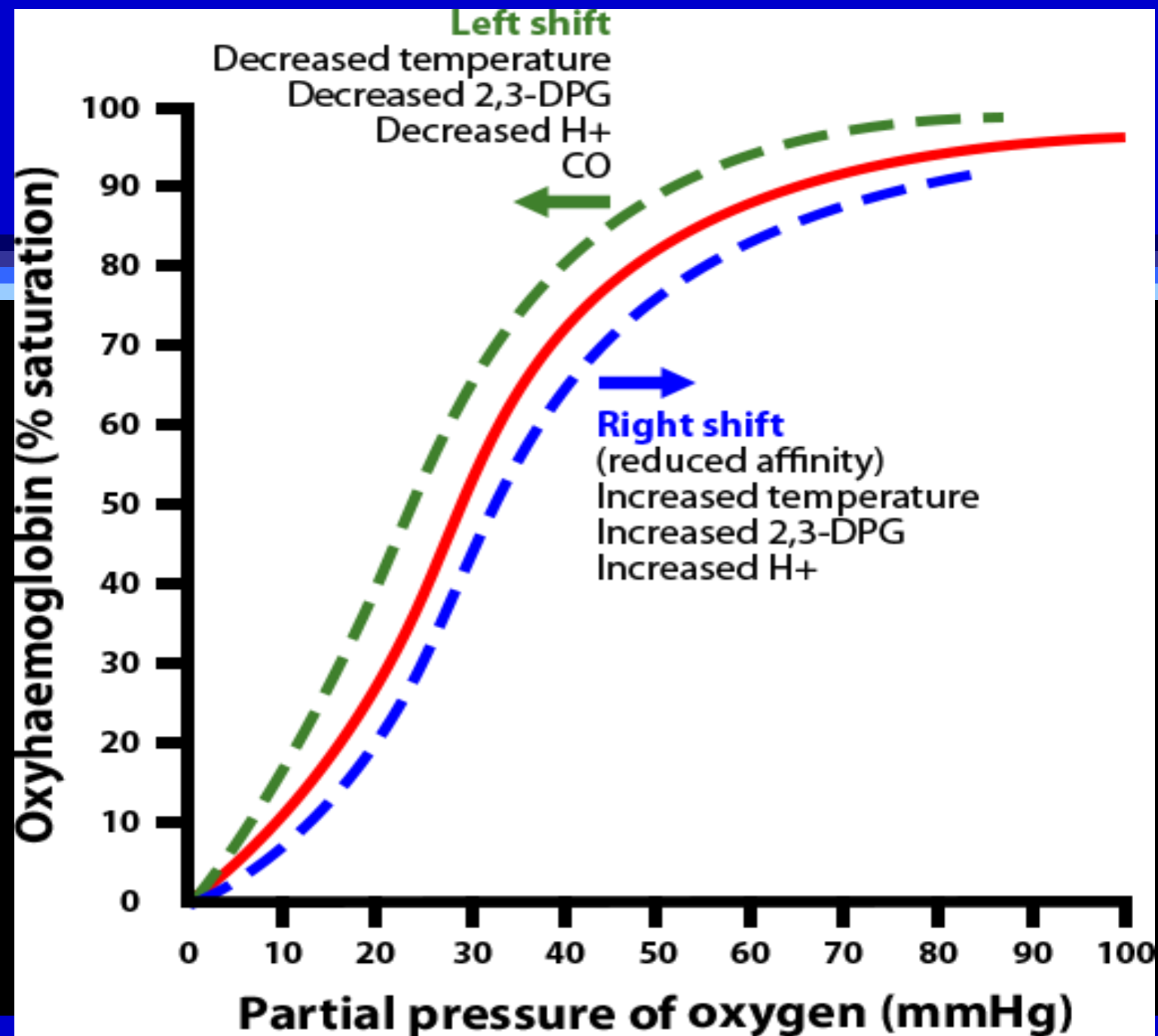
Dilated blood
vessels after birth



TRANSIENT TACHYPNEA OF THE NEWBORN (TTNB)



OXYGEN DISSOCIATION CURVE



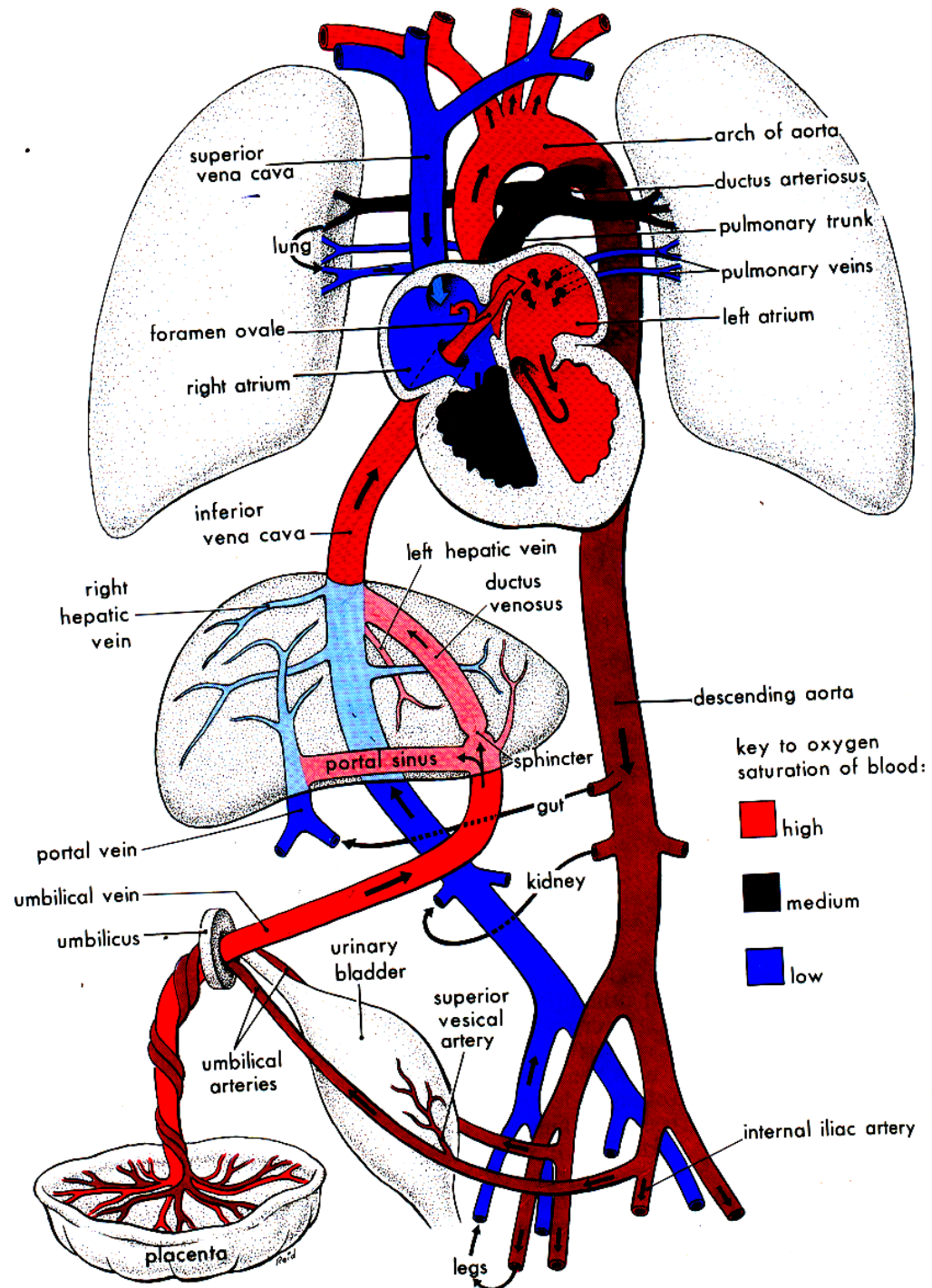
CARDIOVASCULAR SYSTEM

Cardiovascular System

8-12 weeks' gestation

Fetal circulation :

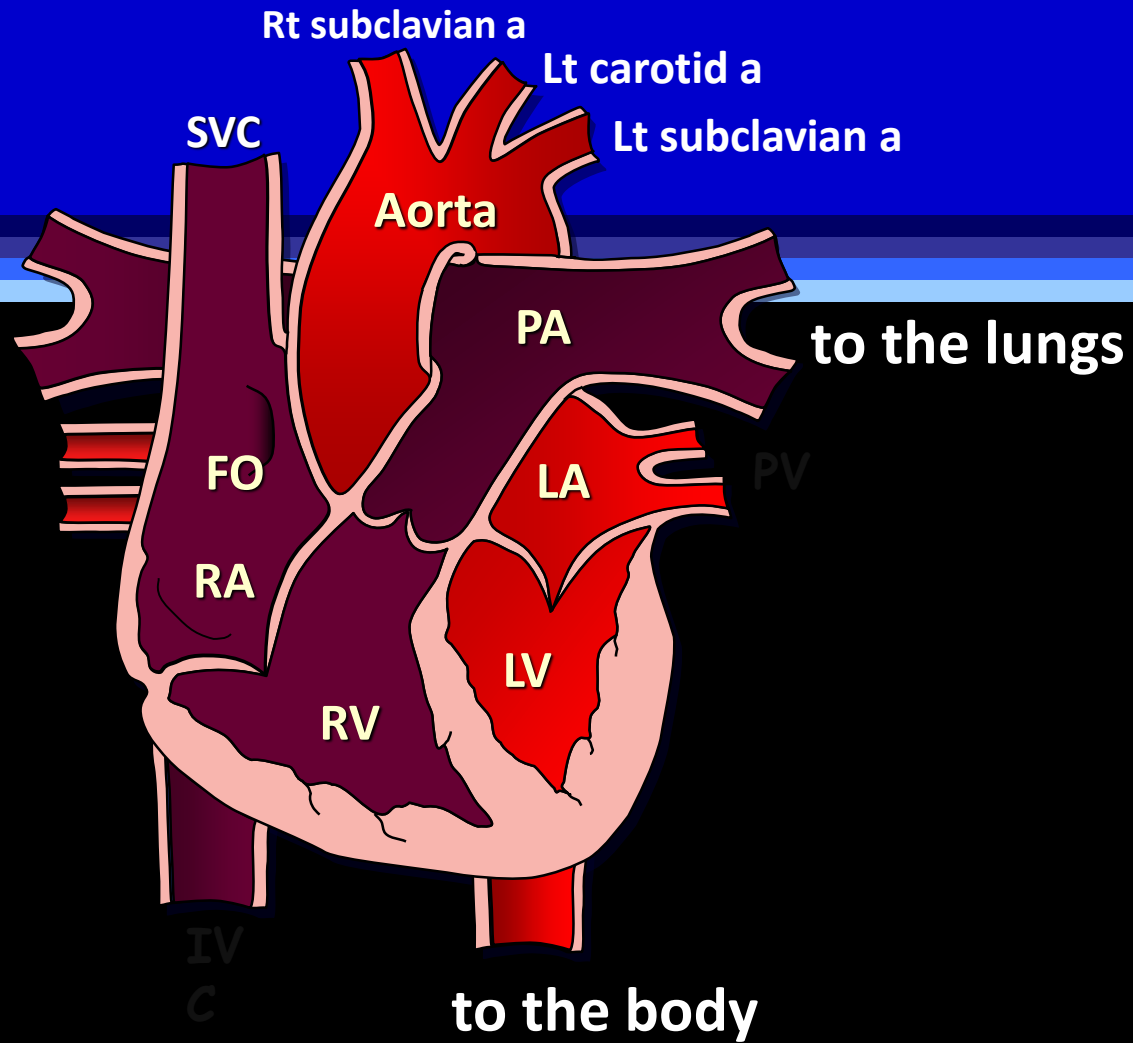
Shunt - ductus arteriosus
- foramen ovale



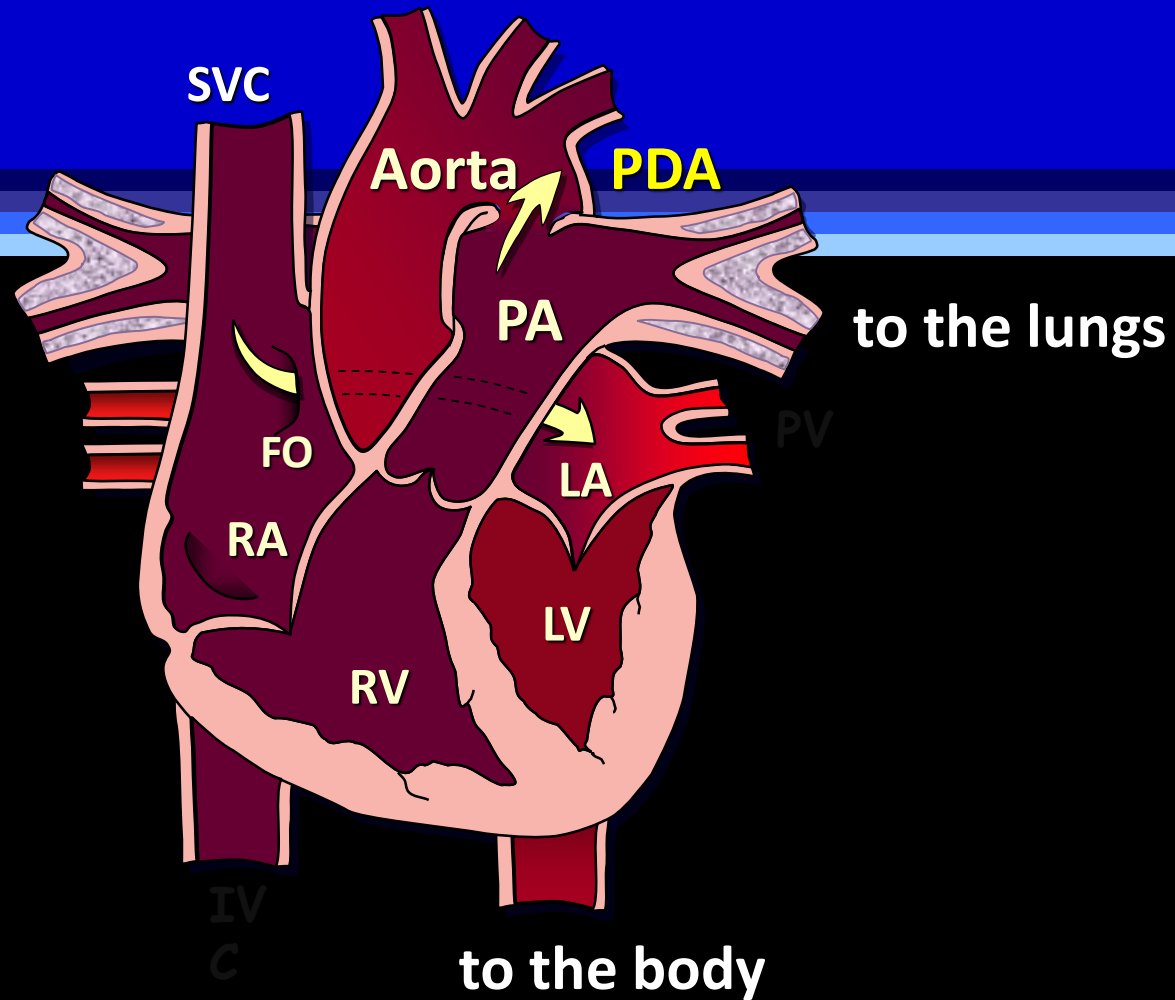
Transition to Extra-uterine Life

Hemodynamic Changes

- * Systemic vascular resistance: increase
- * Pulmonary vascular resistance: decrease
- * Pulmonary blood flow: increase



Normal



Right-to-Left Shunt

GASTROINTESTINAL SYSTEM

Gastrointestinal System

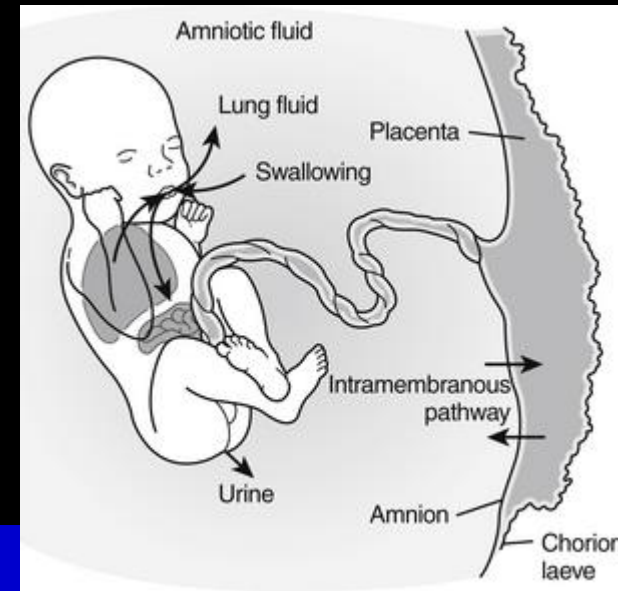
Amniotic fluid swallowing 2-7 mL/day: 16-17 wks

Sucking & swallowing co-ordination: 32-34 wks

Air in stomach : at birth

Air in small intestine : 2-12 hour

Air in large intestine : 24 hour



Gastrointestinal System

Meconium : desquamated intestinal cell, juice, squamous cell, lanugo hair, vernix caseosa

69 % pass meconium within 12 hours

94 % pass meconium within 24 hours

99.8 % pass meconium within 48 hours

Digestion and Absorption

Carbohydrates

lactase 30% of term newborn at 26-34 weeks'

pancreatic amylase low level

salivary amylase



Digestion and Absorption

Proteins

initial digestion of protein begins in stomach
hydrochloric acid and pepsin
proximal small intestine

Digestion and Absorption

Lipids

lipase emulsification and hydrolysis triglyceride to form FFA

bile acids emulsification

lipase present in breast milk

medium - chain triglycerides

mucosal absorption to portal vein



HEMATOLOGIC SYSTEM

Normal Hematologic Value

Value	<u>Gestational age(wk)</u>						
	28	34	term cord blood	D1	D3	D7	D14
Hb(g/dl)	14.5	15	16.8	18.4	17.8	17	16.8
Hct(%)	45	47	53	58	55	54	52
Retic.(%)	5-10	3-10	3-7	3-7	1-3	0-1	0-1
Plt(1000/mm ³)			290	192	213	248	252

URINARY SYSTEM

Urinary System

Fetal urine : amniotic fluid

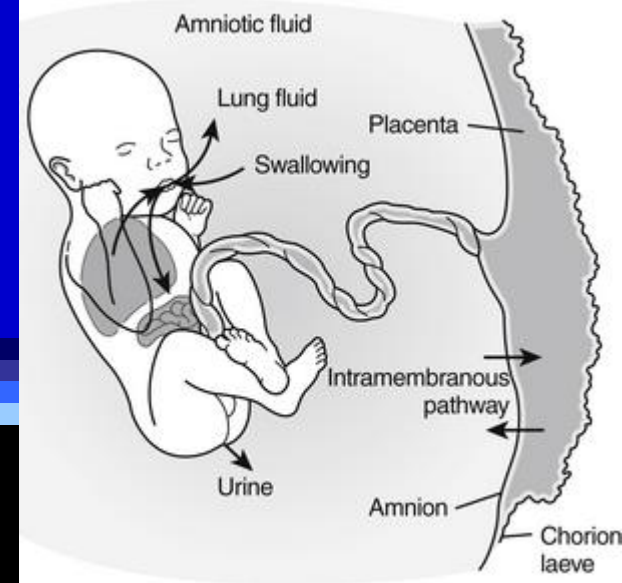
Urine volume 16-44 mL at birth

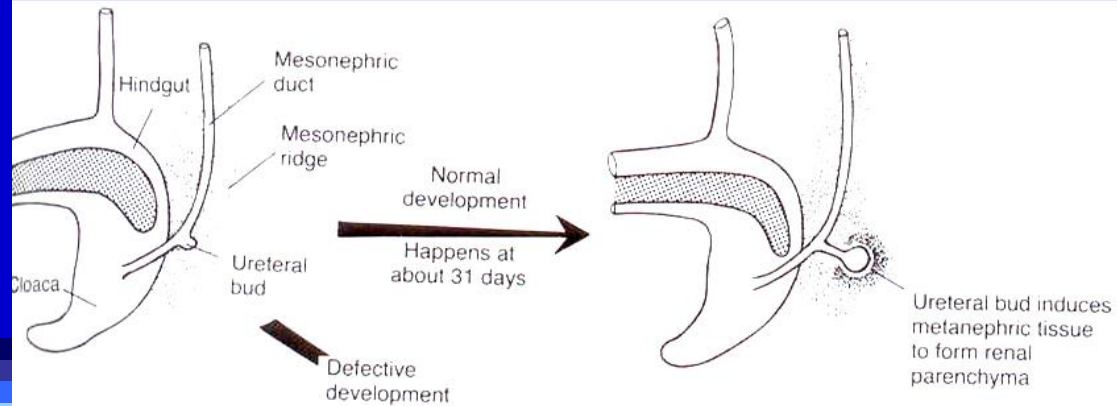
93% void in 24 hours

99% void in 48 hours

GFR depend on gestational age

Urine exam: low sp. gravity, pH 6-7, urate





RENAL AGENESIS

LACK OF URINE
into amniotic cavity

Relative lack of amniotic
fluid during fetal life

Amnion
nodosum

Pulmonary
hypoplasia

Death from
respiratory
insufficiency

Fetal
compression

Breech
presentation

Altered
facies

Abnormal
positioning of
hands and feet



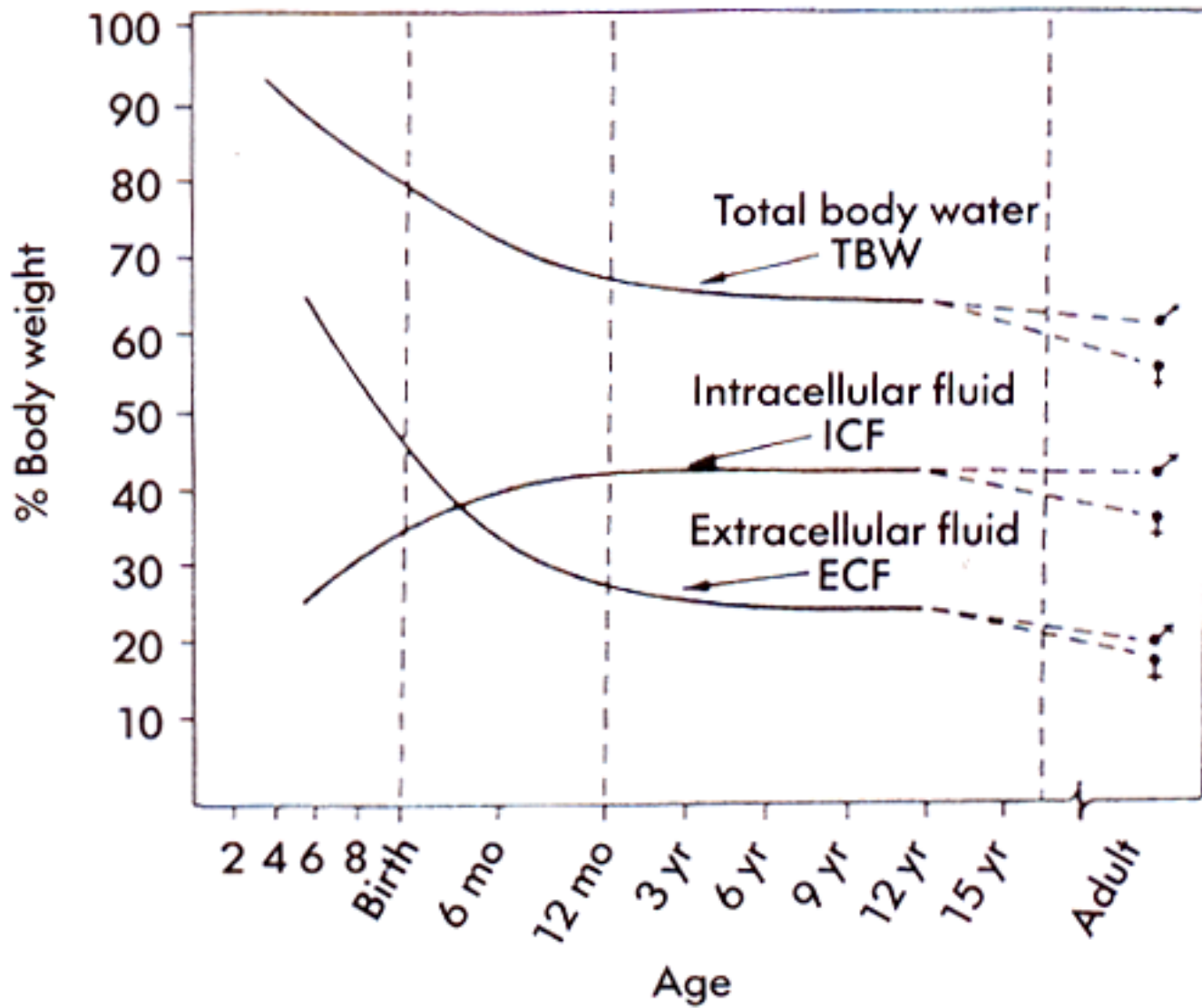
Urinary System

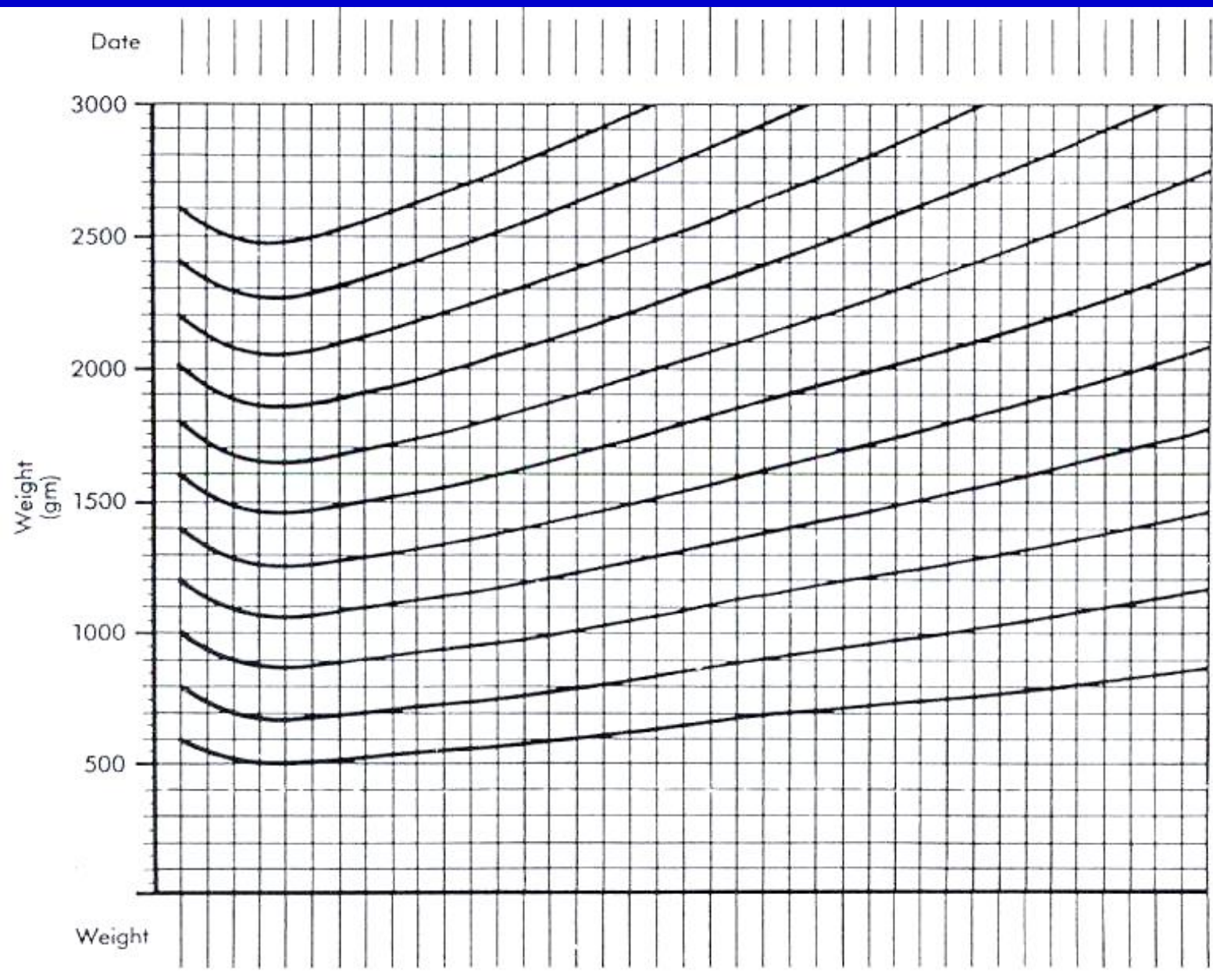
Creatinine

at birth 0.8 mg/dL = maternal Cr

1 week 0.5 mg/dL

1 month to 1 year 0.4 mg/dL





CENTRAL NERVOUS SYSTEM

Primitive Reflex

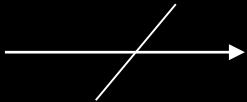


Reflexes	Age reflex appears	Age reflex disappears
Moro	28-32 wks.	4-5 mo.
Palmar Grasp	28 wks.	4-5 mo.
Plantar Grasp	37 wks.	9-12 mo.
Rooting-Sucking	34-38 wks.	3-4 mo.
Tonic Neck	34-38 wks.	5-6 mo.
Parachute	6-9 mo.	

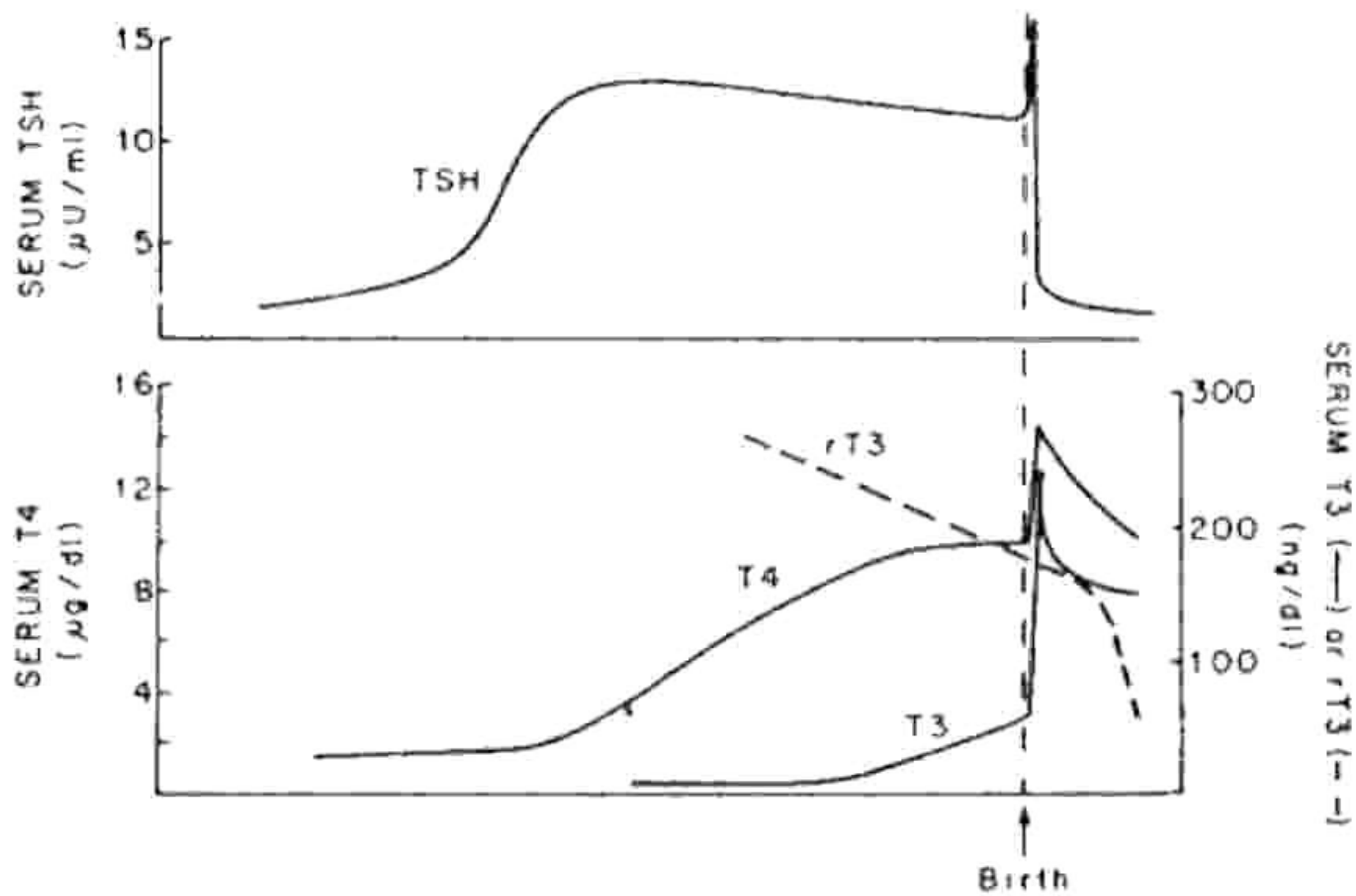
ENDROCRINE SYSTEM

Thyroid Gland

Hypothalamus-Pituitary-Thyroid axis

T3, T4, TSH  placenta

TRH, antibody, drugs  placenta



IMMUNOLOGICAL SYSTEM

Immunological System

Non-specific mechanism :

cell - mediated immune system

complement system :

classical pathway

alternative pathway

Immunological System

Specific mechanism

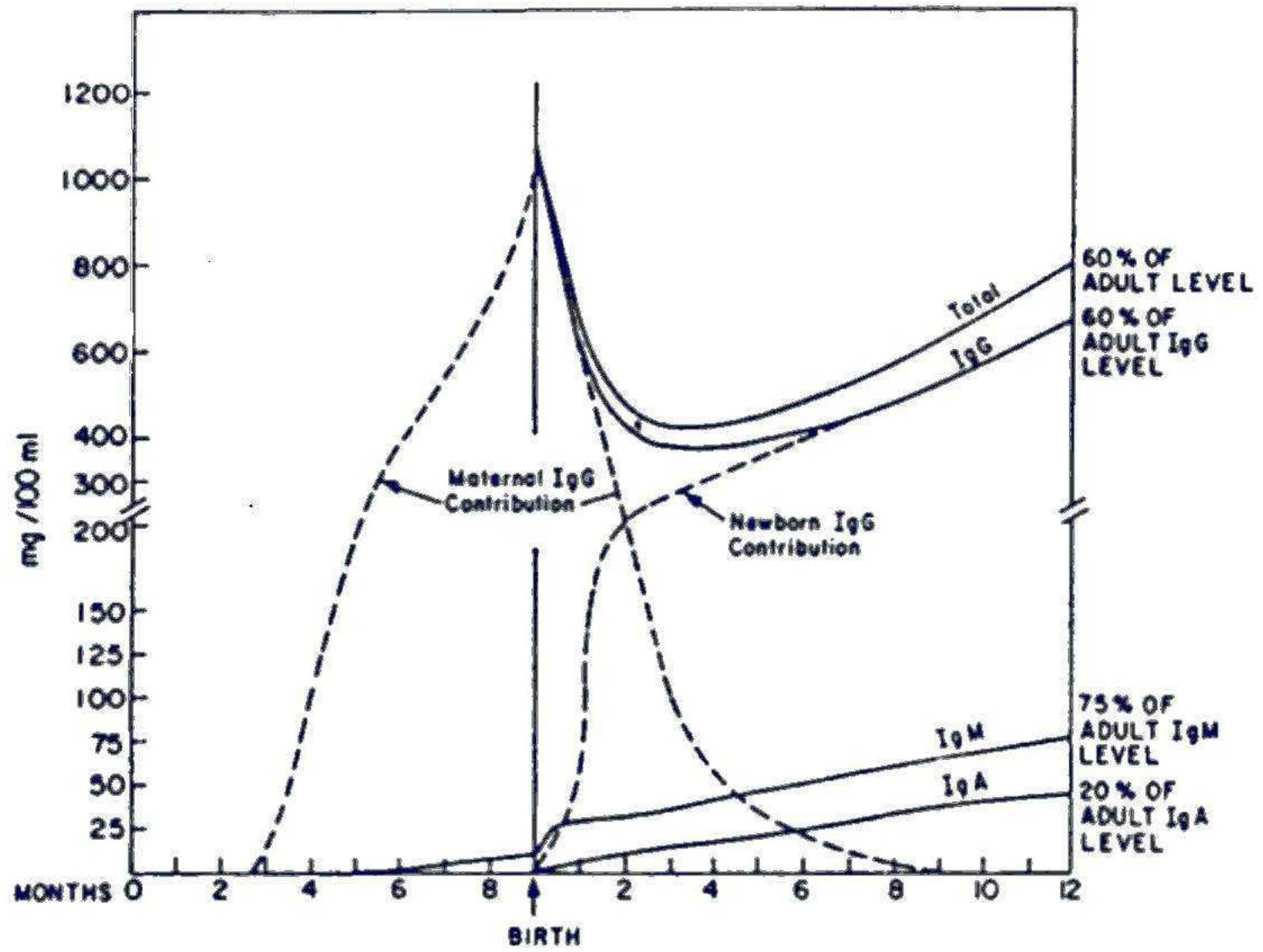
Immunoglobulin

IgG pass placenta

IgM at birth: intrauterine infection

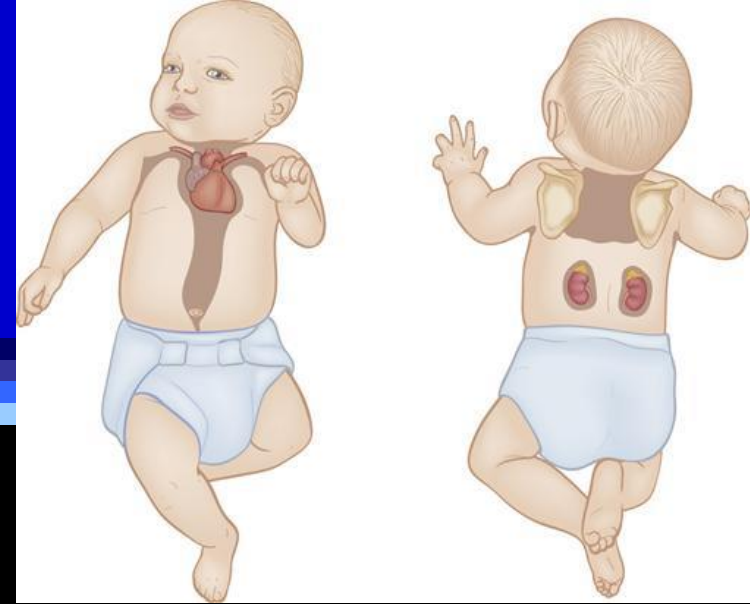
IgA IgE IgD

cell - mediated immune system



THERMOREGULATORY SYSTEM

Heat Production



Non shivering system

Brown fat 2-6% BW

nape of neck , interscapular, mediastinum,
perinephric ,adrenal gland

Triglyceride $\longrightarrow$ FFA + glycerol

Heat Loss

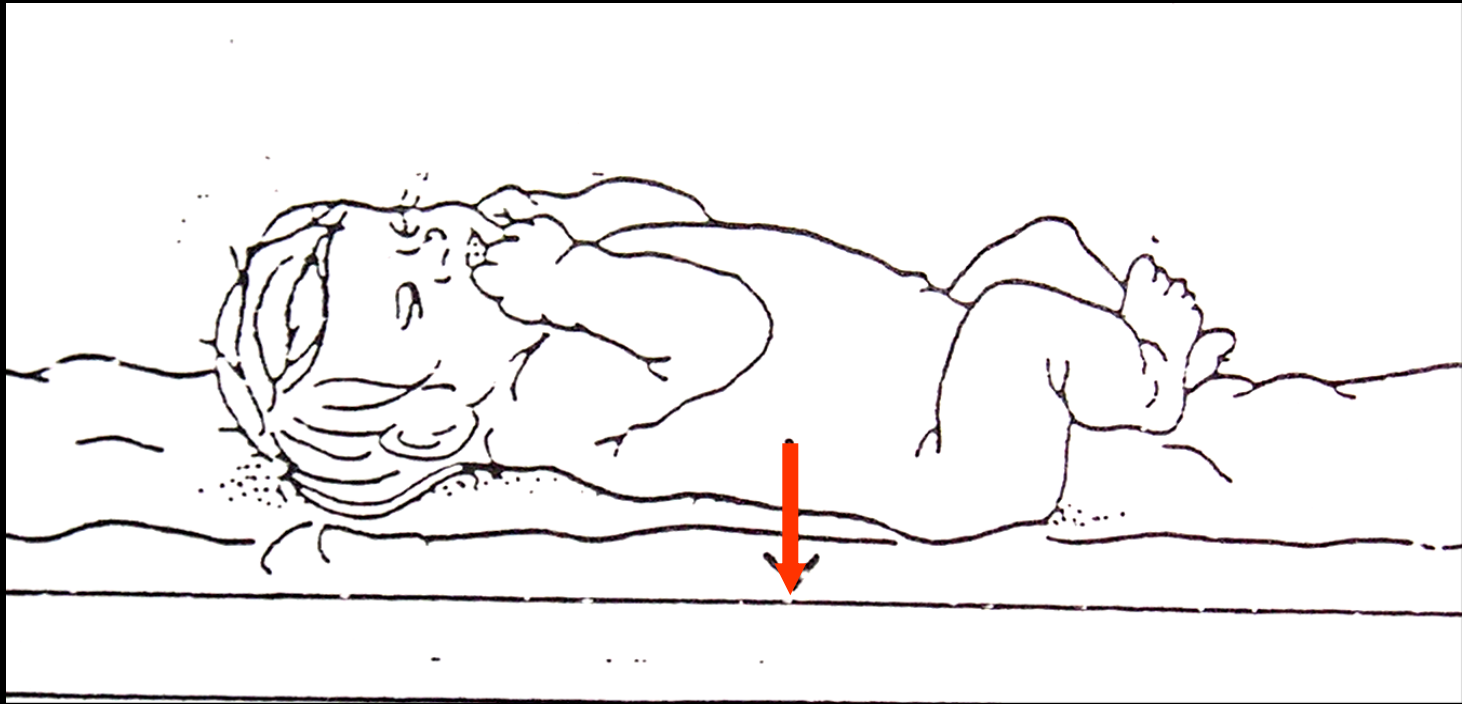
Conduction

Convection

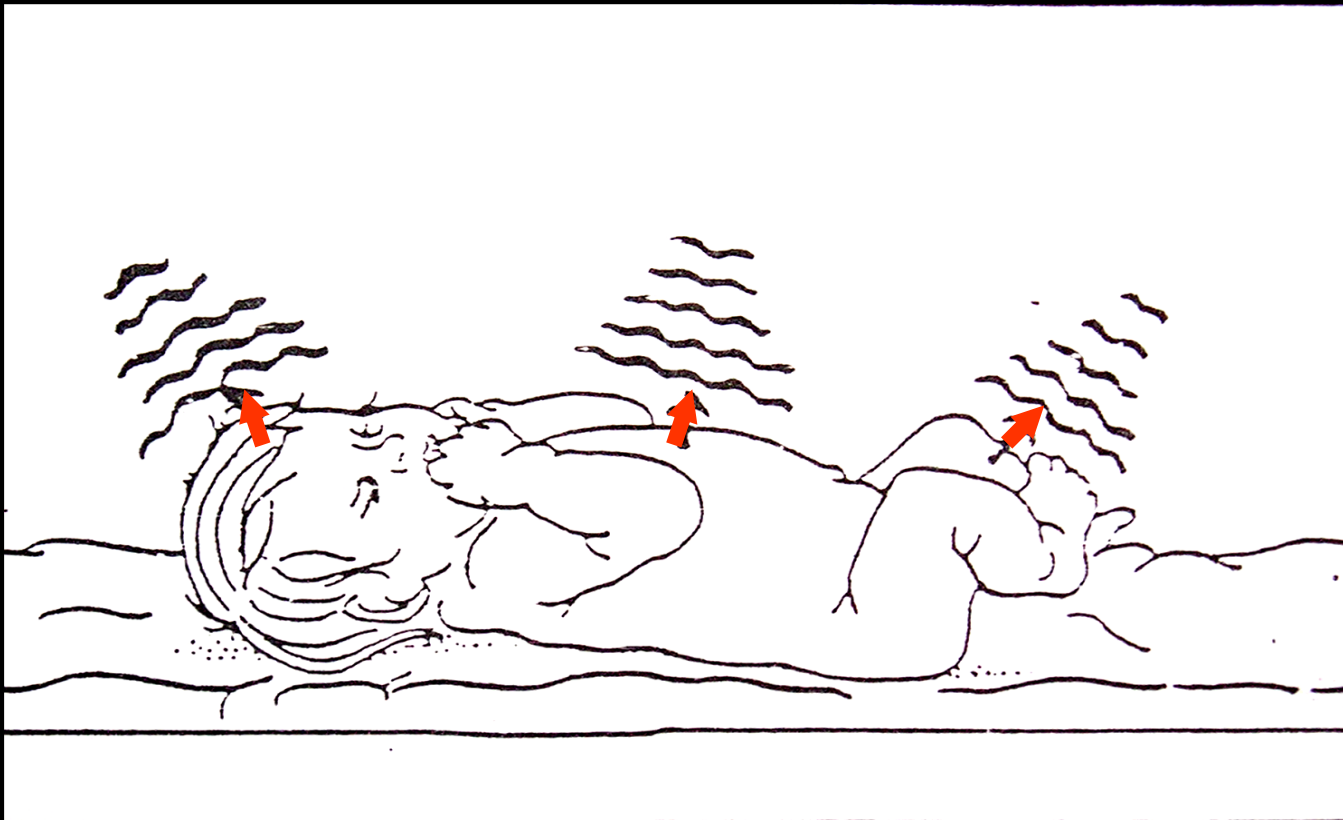
Evaporation

Radiation

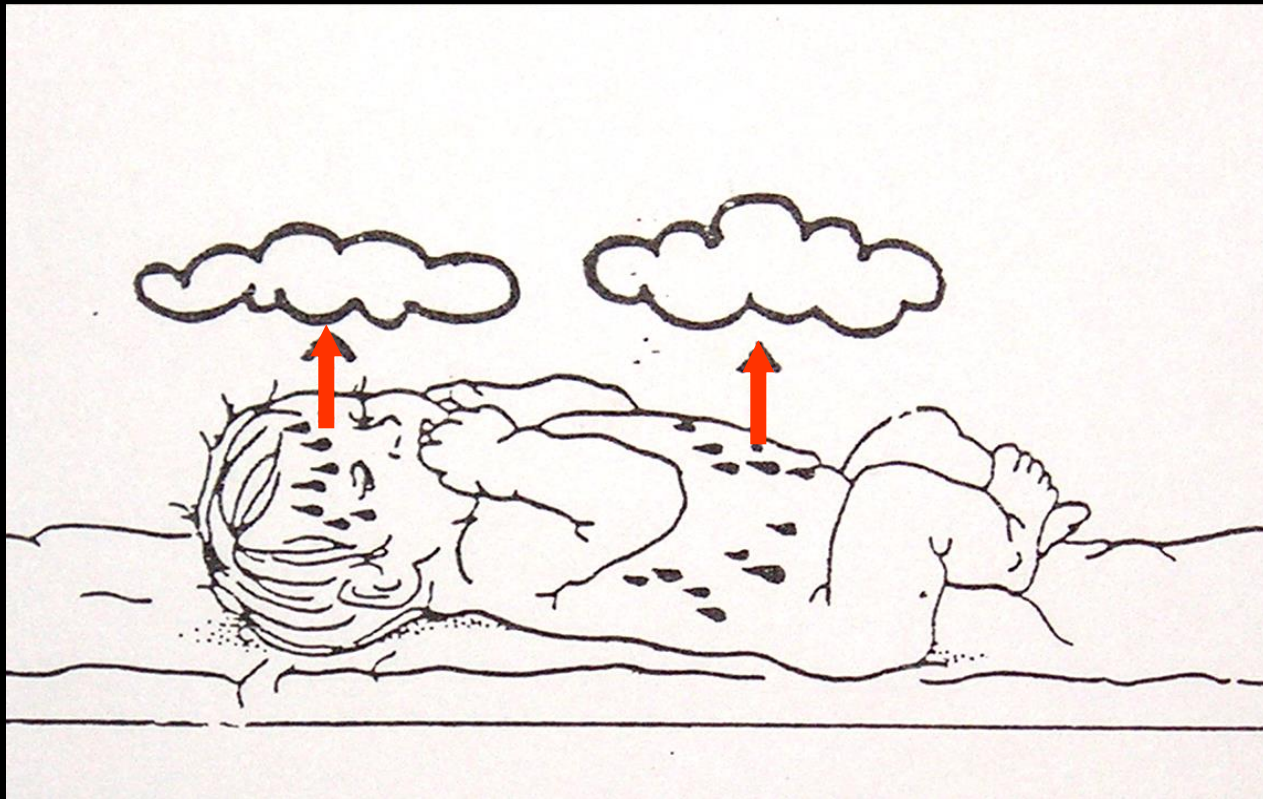
Conduction



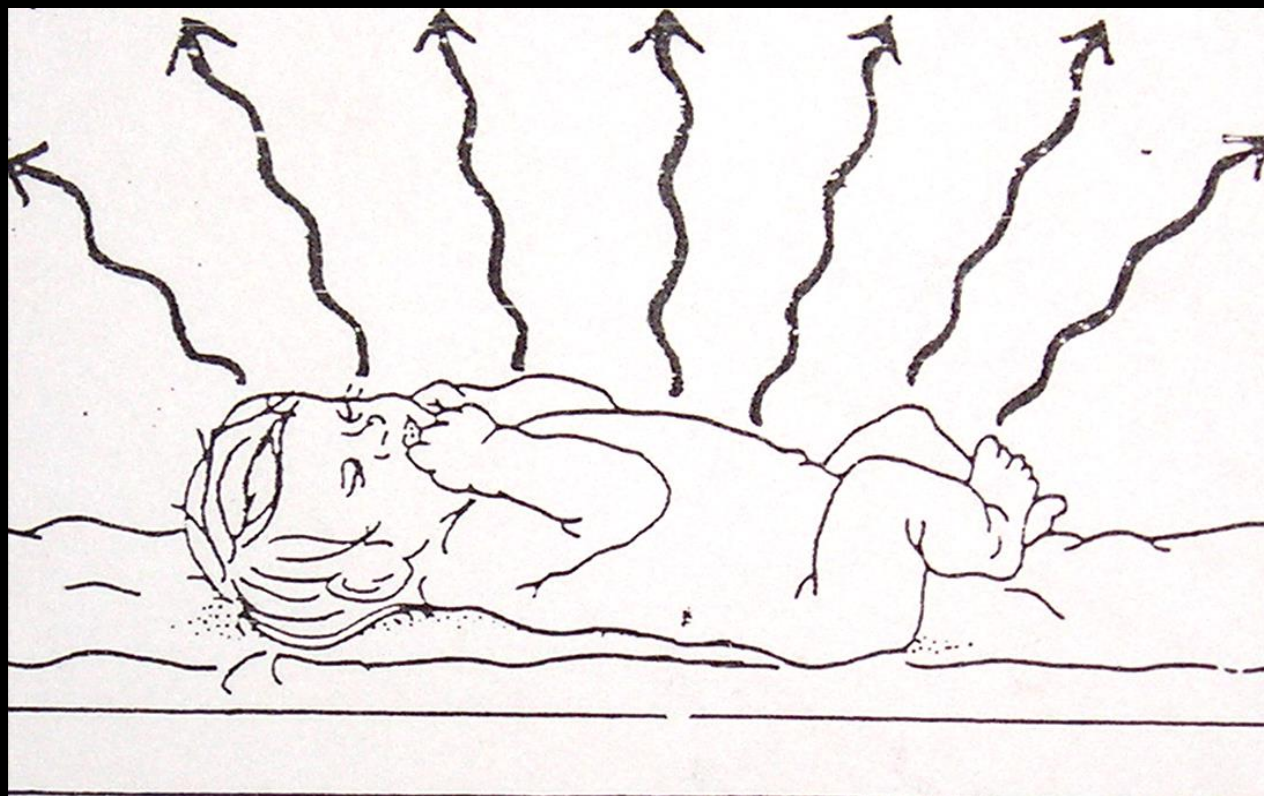
Convection



Evaporation



Radiation

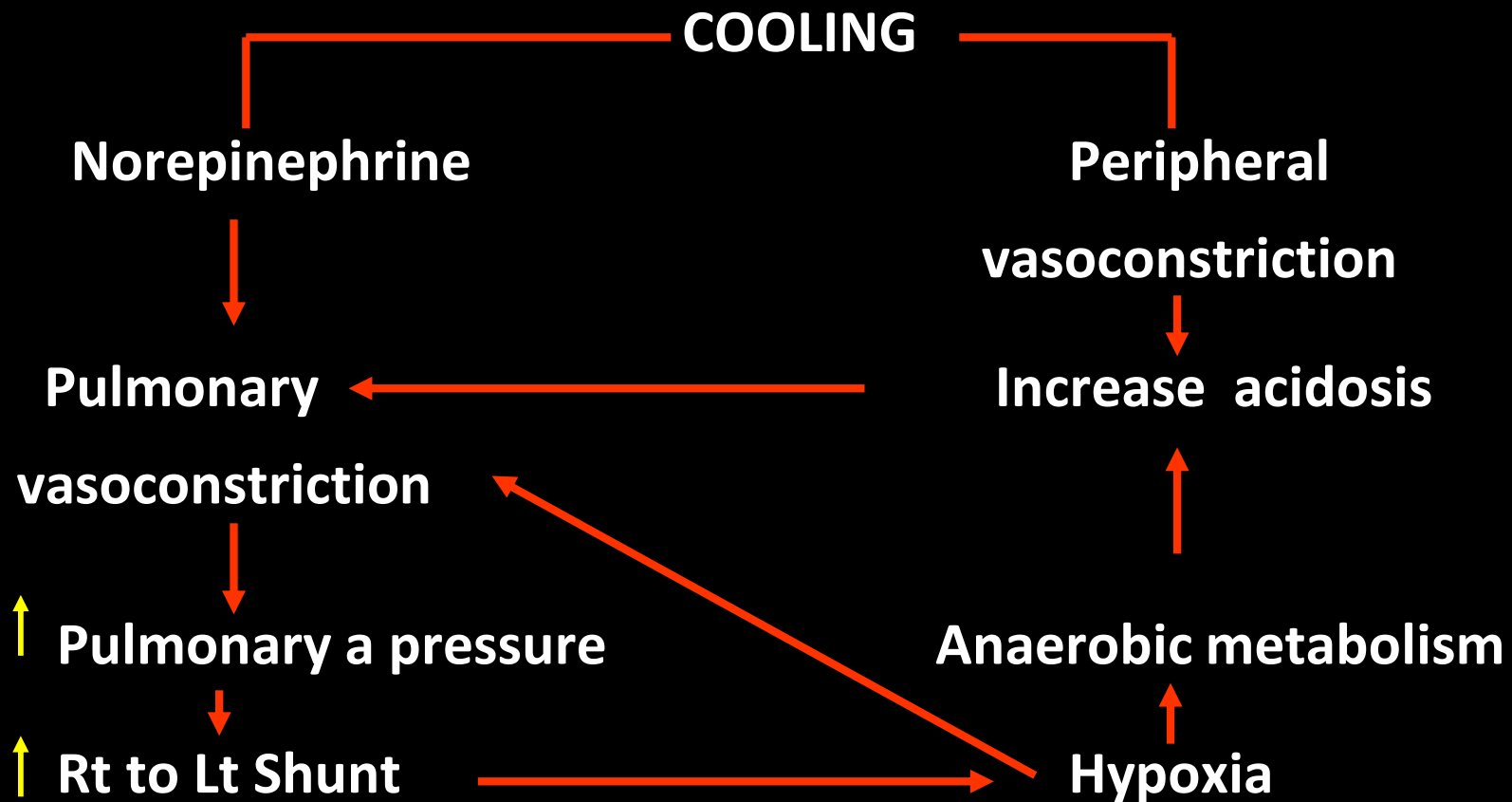


Hypothermia

Rectal temperature $< 36.5^{\circ}\text{C}$

Skin temperature $< 36.0^{\circ}\text{C}$

Vicious circle resulting from cooling in the neonate



Hypothermia

Prevention

Delivery room temperature $>25^{\circ}\text{C}$

Drying the infant

Place on heated radiant warmer

Covering infant with warmed blankets

Transport incubator

Incubator



Neutral Thermal Environment

Range of thermal environment in which a baby with a normal body temperature has a minimal metabolic rate and can maintain body temperature



อายุและน้ำหนัก (ก.)	อุณหภูมิ (°ซ) (พิสัย)	อายุและน้ำหนัก (ก.)	อุณหภูมิ (°ซ) (พิสัย)
0-6 ชั่วโมง		72-96 ชั่วโมง	
ต่ำกว่า 1200	34.0-35.4	ต่ำกว่า 1200	34.0-35.0
1200-1500	33.9-34.4	1200-1500	33.0-34.0
1501-2500	32.8-33.8	1501-2500	31.1-33.2
เกิน 2500 (และ > 36 สัปดาห์)	32.0-33.8	เกิน 2500 (และ > 36 สัปดาห์)	29.8-32.8
6-12 ชั่วโมง		4-12 วัน	
ต่ำกว่า 1200	34.0-35.4	ต่ำกว่า 1500	33.0-34.0
1200-1500	33.5-34.4	1501-2500	31.0-33.2
1501-2500	32.2-33.8	เกิน 2500 (และ > 36 สัปดาห์)	
เกิน 2500 (และ > 36 สัปดาห์)	31.4-33.8	4-5 วัน	29.5-32.6
12-24 ชั่วโมง		5-6 วัน	29.4-32.3
ต่ำกว่า 1200	34.0-35.4	6-8 วัน	29.0-32.2
1200-1500	33.3-34.3	8-10 วัน	29.0-31.8
1501-2500	31.8-33.8	10-12 วัน	29.0-31.4
เกิน 2500 (และ > 36 สัปดาห์)	31.0-33.7	12-14 วัน	
24-36 ชั่วโมง		ต่ำกว่า 1500	32.6-34.0
ต่ำกว่า 1200	34.0-35.0	1501-2500	31.0-33.2
1200-1500	33.1-34.2	เกิน 2500 (และ > 36 สัปดาห์)	29.0-30.8
1501-2500	31.6-33.6	2-3 สัปดาห์	
เกิน 2500 (และ > 36 สัปดาห์)	30.7-33.5	ต่ำกว่า 1500	32.2-34.0
36-48 ชั่วโมง		1501-2500	30.5-33.0
ต่ำกว่า 1200	34.0-35.0	3-4 สัปดาห์	
1200-1500	33.0-34.1	ต่ำกว่า 1500	31.6-33.6
1501-2500	31.4-33.5	1501-2500	30.0-32.7
เกิน 2500 (และ > 36 สัปดาห์)	30.5-33.3	4-5 สัปดาห์	
48-72 ชั่วโมง		ต่ำกว่า 1500	31.2-33.0
ต่ำกว่า 1200	34.0-35.0	1501-2500	29.5-32.2
1200-1500	33.0-34.0	5-6 สัปดาห์	
1501-2500	31.2-33.4	ต่ำกว่า 1500	30.6-32.3
เกิน 2500 (และ > 36 สัปดาห์)	30.1-33.2	1501-2500	29.0-31.8

Thank You

