VIRTUAL CHILDREN'S HOSPITAL FOR LEARNING PEDIATRIC NURSING

Module 2

Theory material 2:

Anatomical and Physiological Characteristics of Organ Systems in Neonates

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Preparation Before Neonatal Assessment

- **Family-centered care:** taking into consideration cultural needs, parental concerns, encouragement of parental participation
- **Environment:** warmth room temperature, lighting, quiet, correct identification, infection control precautions, privacy
- **Equipment:** stethoscope, pulse oximeter, thermometer, records for documentation

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History

- Maternal and paternal genetic history eg. medical illnesses
- Past pregnancies of mother eg. still births, genetic or syndromic conditions
- Prenatal history eg. gestational diabetes, preeclampsia
- Labour eg. prenatal screening tests
- Birth eg. gestational age, Apgar score, need for resuscitation

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Respiratory System

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Look

- **Chest:** size, shape, symmetry, trachea in midline
  - From ages 6 months to 2 years, it is important that the chest circumference closely matches the head circumference, with the chest circumference expected to exceed the head circumference by age 2 years. This measurement assists healthcare providers in assessing normal growth patterns.

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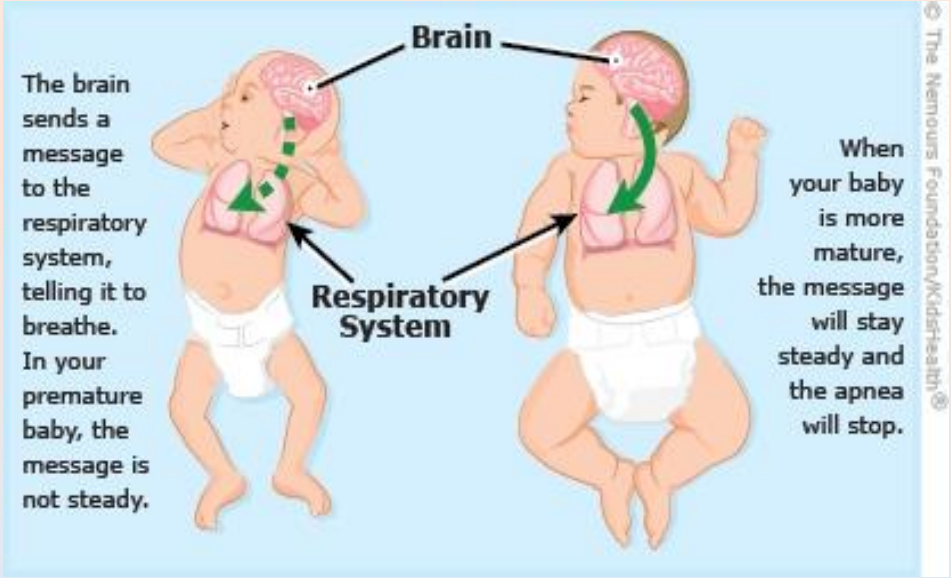
Respiratory System

Look

- **Breathing pattern:** regular, irregular, shallow, apnoic
- **Chest movement and effort with respiration:**
  - Mild, moderate, severe effort
  - Paradoxical breathing (abdomen moves outward and the chest moves inward) is normal
  - Periodic breathing, which can include episodes of apnea lasting less than 10 seconds without cyanosis or bradycardia, is considered normal and is attributed to the neurologic immaturity of the respiratory drive



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Respiratory System

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Look

- **Signs of upper airway obstruction:** increased effort or laboured breathing
- **Skin colour:** peripherally and centrally
- **Respiratory rate (RR):** count by observing the abdominal movements, count for one full minute for accuracy, normal RR for age: 35 to 60
- **Use of accessory muscles:** tracheal tug, intercostal, suprasternal, substernal, supraclavicular, abdominal, head bob, nasal flaring
- **SpO2:** normal SpO2: ≥95%

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Respiratory System

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Listen

- Breath sounds during breathing: abnormal sound include stridor, wheezing, crackles/rales, grunting
- Cough e.g. barking cough, dry cough, productive cough

Feel

- Chest expansion: symmetry of chest movement, feeling of fremitus (vibrations)
- Capillary return: normal return of colour in nails is ≤2''

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Respiratory System

At birth, the alveoli in neonates are thick-walled, and infants have only about 10% of the total number of alveoli found in adult lungs. Over the first 8 years of life, the number of alveoli increases significantly, and existing alveoli grow in size. This developmental process affects gas exchange because the oxygen consumption rate in neonates is nearly double that of adults. It necessitates a higher respiratory rate, which is critical for maintaining adequate oxygen levels.

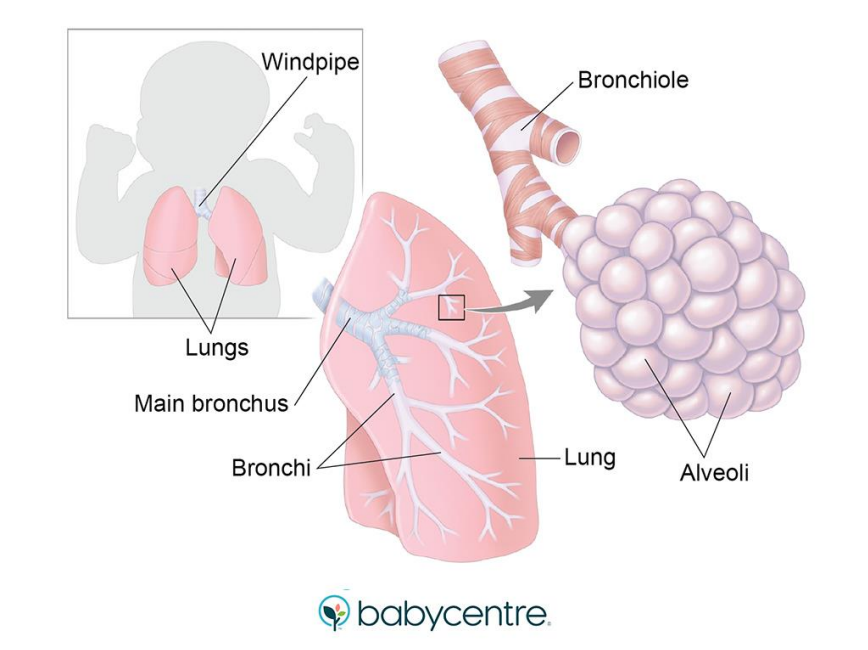

Table 1 – Normal values for age: respiratory rate.

Respiratory rate for age	1 month	1 year	2 year	5 year	10 year
Upper limit of normal range	60	50	40	30	25
Lower limit of normal range	25	20	18	17	14

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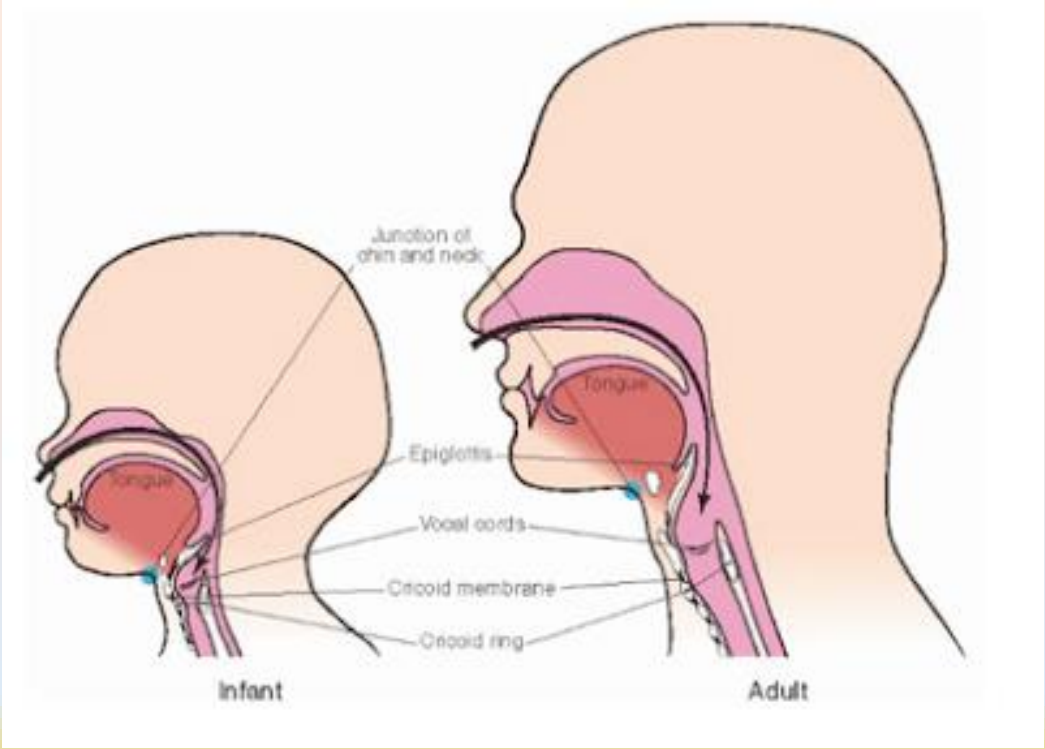
Respiratory System

- Neonates have a proportionately small and narrow oropharynx, and their trachea is shorter with a small diameter. The tracheal cartilage is elastic and easily collapsible, which raises the potential for airway obstruction due to mucus or foreign bodies. The trachea grows in diameter until age 5 years and triples in size from birth through.
- Throughout the early years of development (from birth to around 6 years of age), infants and young children primarily use their diaphragm and abdominal muscles for breathing.



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Cardiovascular System

- **Pulses**
  - Apical pulse is more reliable (between 4th and 5th intercoastal)
  - Brachial and femoral are used more in neonates
- **Heart rate (HR):** 120 to 160 normal HR
- **Heart rhythm:** respiratory sinus arrythmia is normal in neonates since their heart rate may fluctuate more with respiratory cycles
- **Blood pressure:** assessed from the upper and lower extermities (average systolic/diastolic pressure is 70/45mmHg in term babies, 60/20mmHg in preterm babies, and 65/44mmHg at 1 to 3 days of age)
- **Oedema:** can be found periorbital (around the eyes), scrotal, or limb. However, physiological oedema is common in neonates in the first few days of life.
- **Skin colour:** paleness, cyanosis
- **Heart sounds:** murmurs

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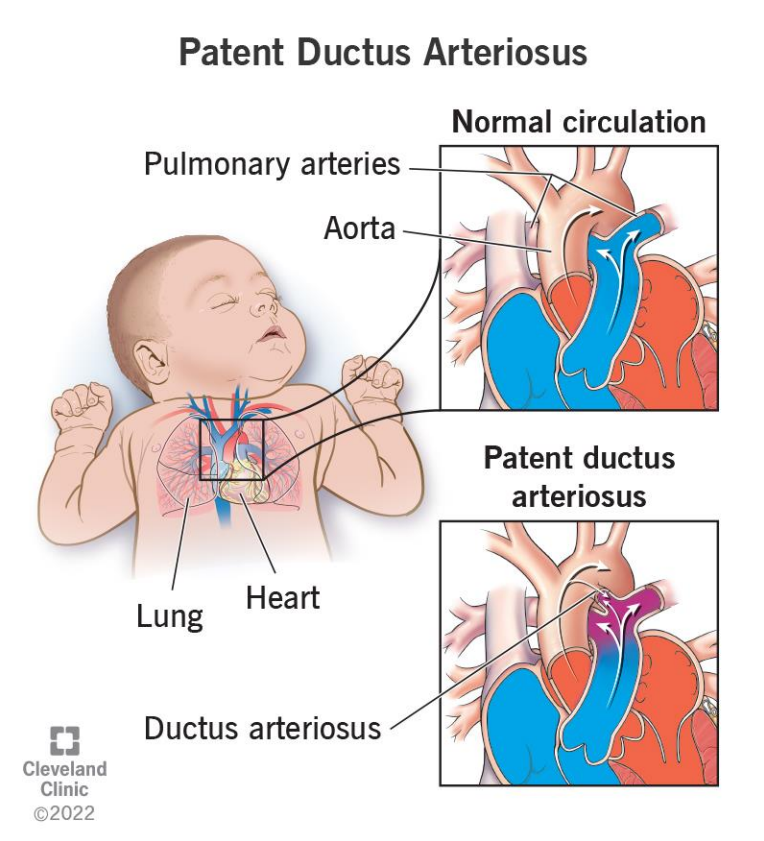
Cardiovascular System

- At birth, significant changes occur as the newborn transitions from fetal circulation, where gas exchange happens through the placenta, to independent pulmonary respiration and circulation.
- Ductus arteriosus closes about 10 to 15 hours after birth; fibroses within 2 to 4 weeks of age; systolic murmurs may be audible in the first 24 to 48 hours of life because of transition from fetal circulation.



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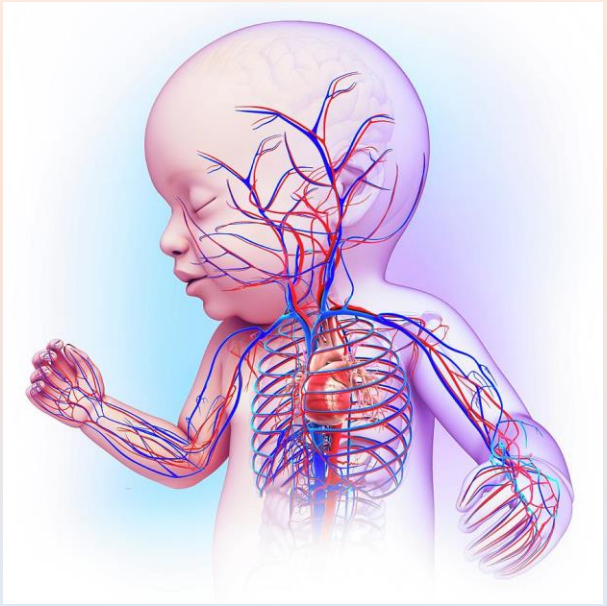
Cardiovascular System

- Newborns have an average blood volume of approximately 80-100 mL/kg, higher than older children or adults in relation to body weight.
- The heart is positioned horizontally in newborns and becomes more vertical as the child grows.



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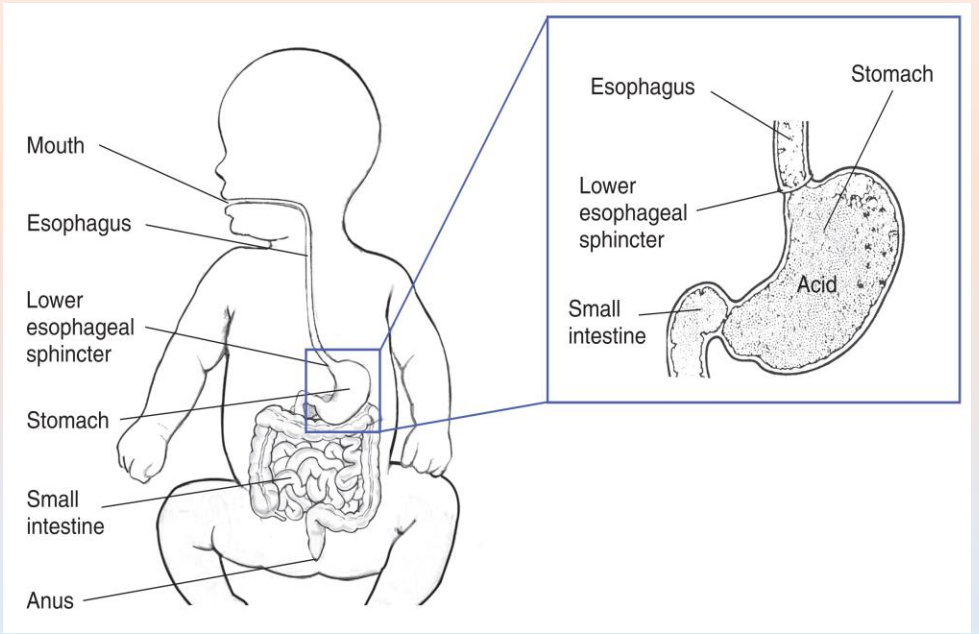
Digestive System

- **Feeding:** newborns do not have a complete set of milk teeth, which means they cannot chew food. Feeding is based on the sucking and swallowing reflexes
- **Milk digestion:** The esophagus is short and elastic, allowing for the rapid transport of milk to the stomach. The lower esophageal sphincter is less developed, which can lead to reflux.
- **Quantity of feeding:** A newborn's stomach is small (capacity of about 30-90 ml), requiring them to eat more frequently. Stomach capacity reaches approximately 500 mL by toddler age and 1000-1500 mL by adolescence.



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Digestive System

- **Abdomen shape and symmetry:** organomegaly
- Palpate for enlargement of liver, spleen, kidneys and bladder
- **Bowel sounds:** normally every 10 to 15 seconds
- **Umbilicus:** number of arteries and vein, exomphalos, imphalitis
- Tenderness
- Hernia or other masses

Exomphalos

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Digestive System

- **Anal:** position, patency
- **Stools:** The stools are usually soft and may be mustard yellow in colour. Formula-fed infants usually have fewer bowel movements, averaging about 1 to 4 times a day. Their stools are often firmer and have a different colour, usually tan or yellowish-brown. Meconium should pass within the first 48 hours of life.

Meconium

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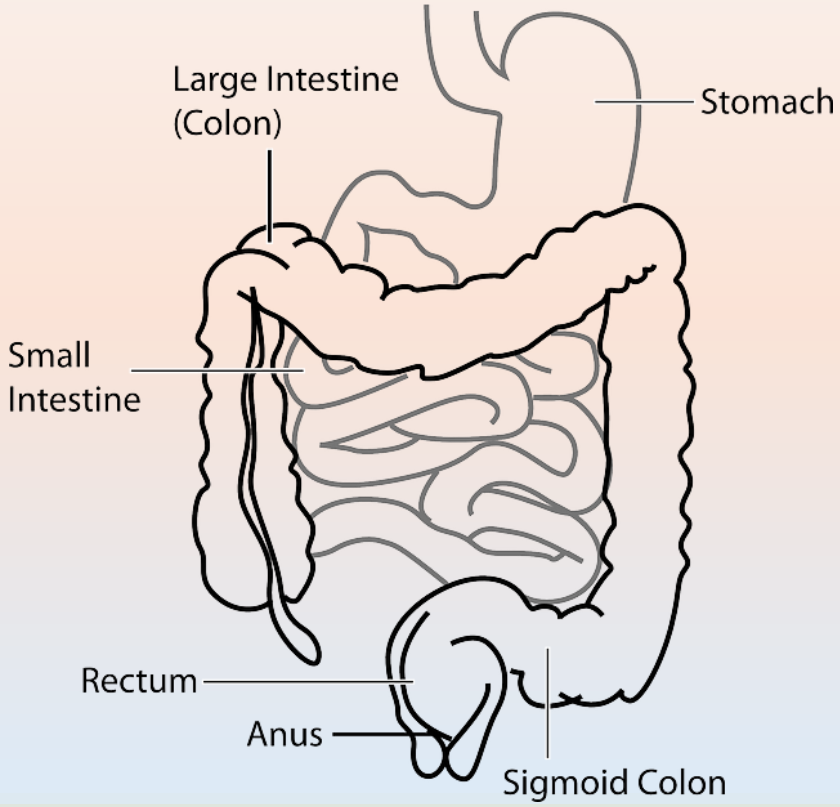
Digestive System

- Small intestine is approximately 200 cm long and crucial for nutrient absorption. The small intestine in newborns is particularly large relative to body size, facilitating efficient nutrient uptake.



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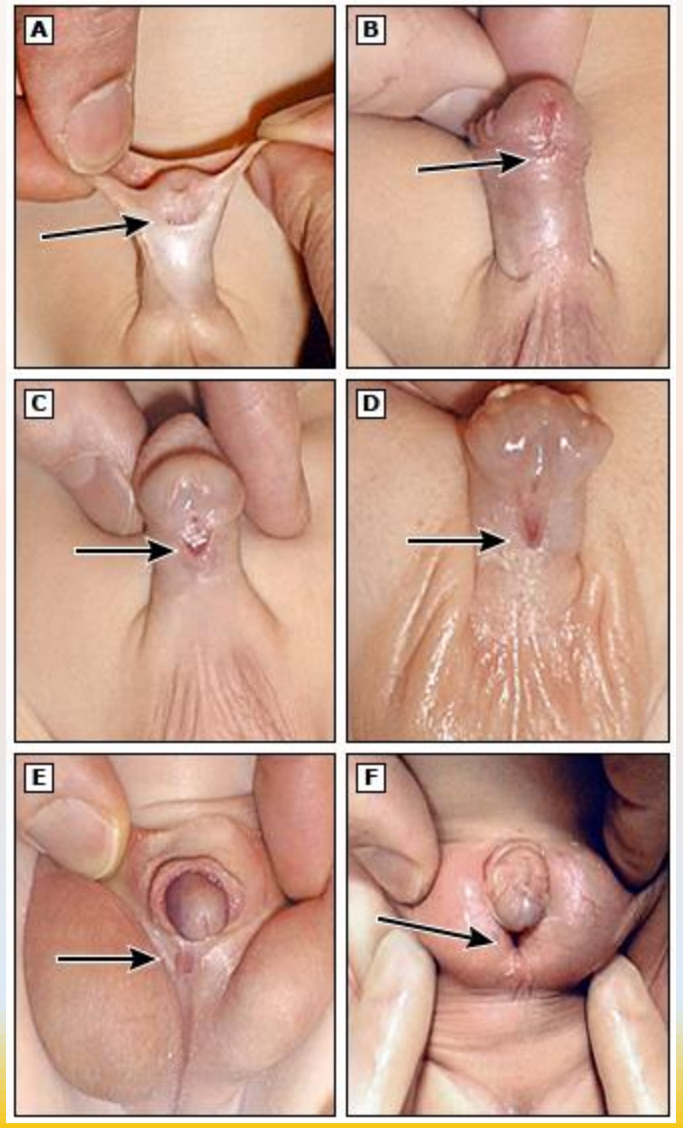
Genitourinary System

- **Urine output:** if passed the first 24 hours, colour, amount. Newborns produce urine relatively quickly after birth, usually within the first 24 hours. The typical output may be about 1-2 mL per kilogram of body weight per hour (1-2ml/kg/hr).
- **Male genitalia:** penis – normal length in term male is 2.5 to 3.5cm-, testes-confirm present and position-, size and colour, other masses –hydrocele-, hypospadias, micropenis – stretched length <2.5cm
- **Female genitalia:** clitoris, labia, hymen



Hypospadias: A,B,C – distal penile shaft, D – mid-penile shaft, E – scrotum, F – perineum

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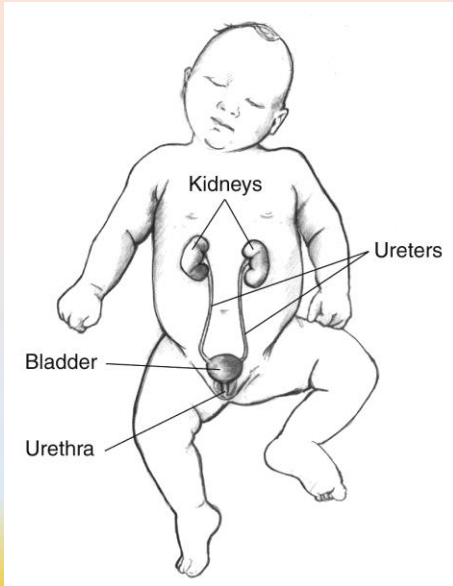
Genitourinary System

- Newborns have two small kidneys (3-4 cm length), but functionally sufficient from birth.
- The ureters in newborns are shorter and more pliable than in older children and adults. They are approximately 7-8 cm long.
- The bladder is small at birth, with a capacity of about 20-50 mL, allowing it to hold only a small amount of urine.
- The bladder wall is relatively thin and highly elastic, enabling it to stretch as it fills.
- In newborn males, the urethra is 4-6 cm, females 2-3 cm long.

- The maturation of urinary control mechanisms, including the bladder and urethral sphincters, takes time. Newborns typically do not have voluntary control over urination, which develops later during infancy.



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Nervous System

- **Behaviour:** level of alertness, activity level
- **Posture:** normally, neonates are in a flexed position (limbs curled towards the body)
- **Muscle tone:** hypotonia, hypertonia, asymmetry of tone
- **Cry:** no cry, high pitched cry
- **Sensory abilities:** newborns possess limited sensory abilities at birth. Their vision is blurry, and they can primarily see contrasts and patterns. Hearing is developed to some degree, as they can recognize their mother's voice.

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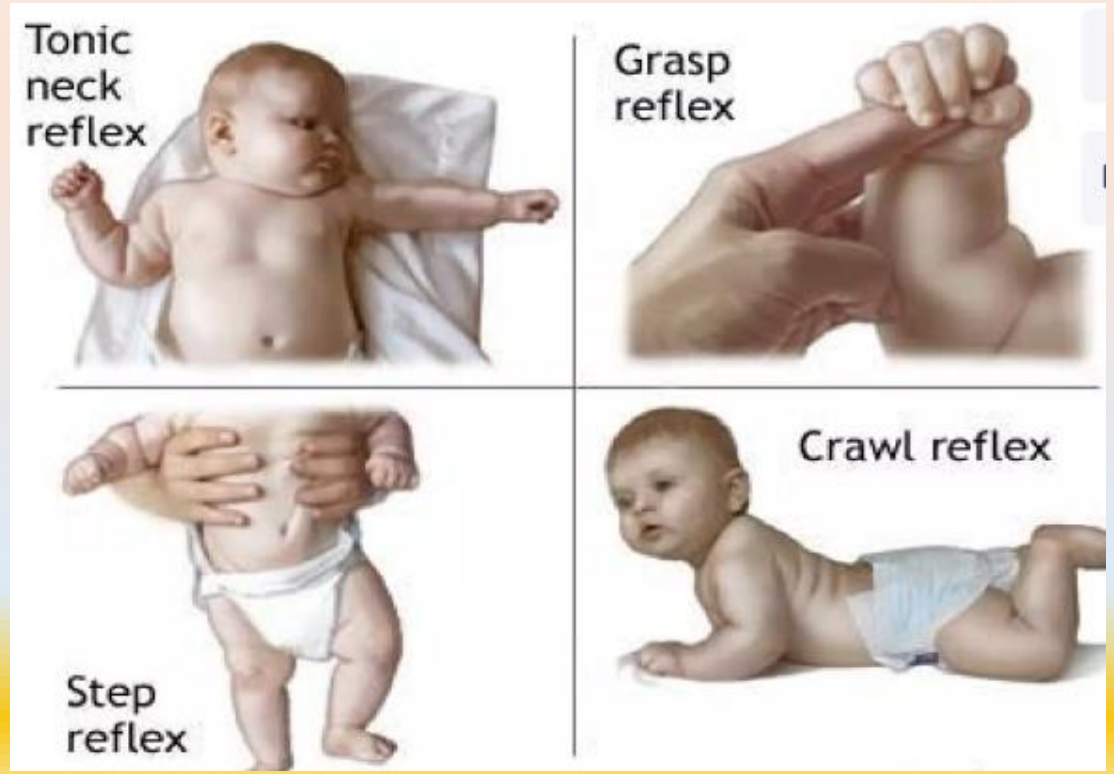
Nervous System

- **Reflexes:** Reflex arcs are well-established in newborns, allowing them to exhibit basic reflexes (e.g., sucking, grasping, rootin, moro, and red reflexes) critical for survival.

Sucking reflex



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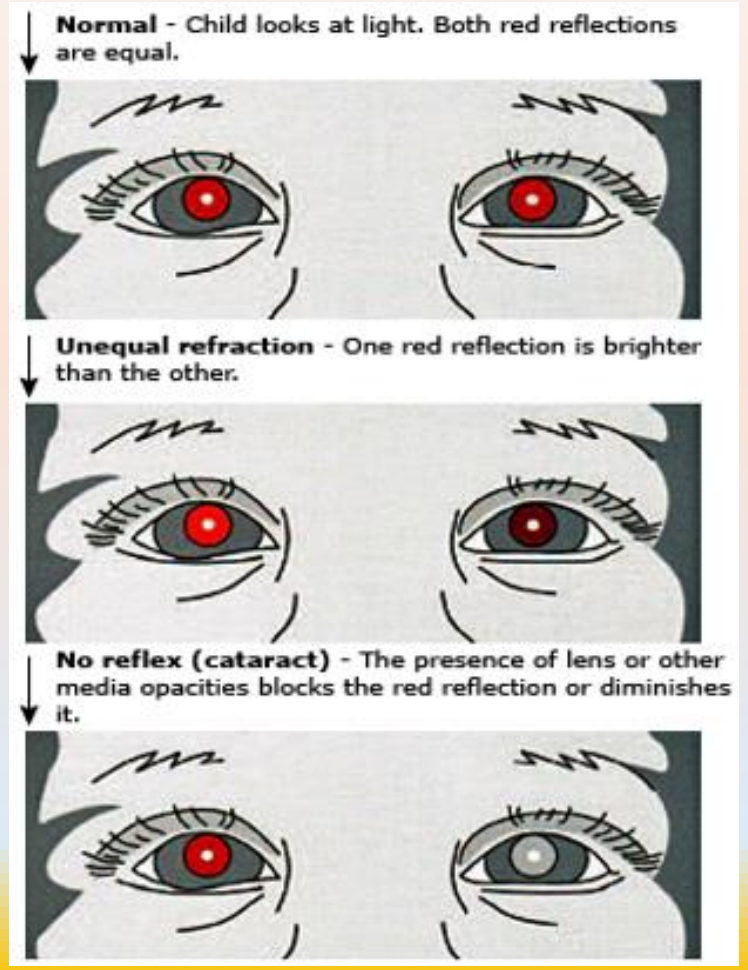
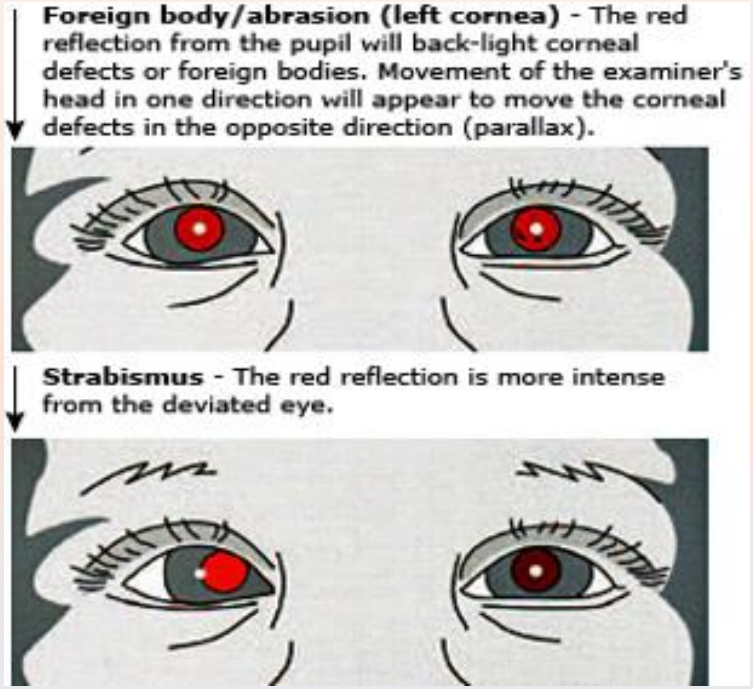
Nervous System

Eye red reflex





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Nervous System

- The newborn's nervous system is not fully developed at birth. Major structures like the brain and spinal cord are present but still immature.
- The brain accounts for about 10% of the newborn's total body weight, which is significantly larger proportionally than in adults. This rapid growth is a hallmark of early development.
- Newborns are born with many neurons, but the synapses (connections between neurons) are still forming. During the first few years of life, there is a rapid increase in synaptic connections, known as synaptogenesis.
- Newborns sleep for a majority of the day (around 16-18 hours), with sleep cycles that differ from adults, predominantly consisting of REM sleep, which is important for brain development.

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Musculoskeletal System

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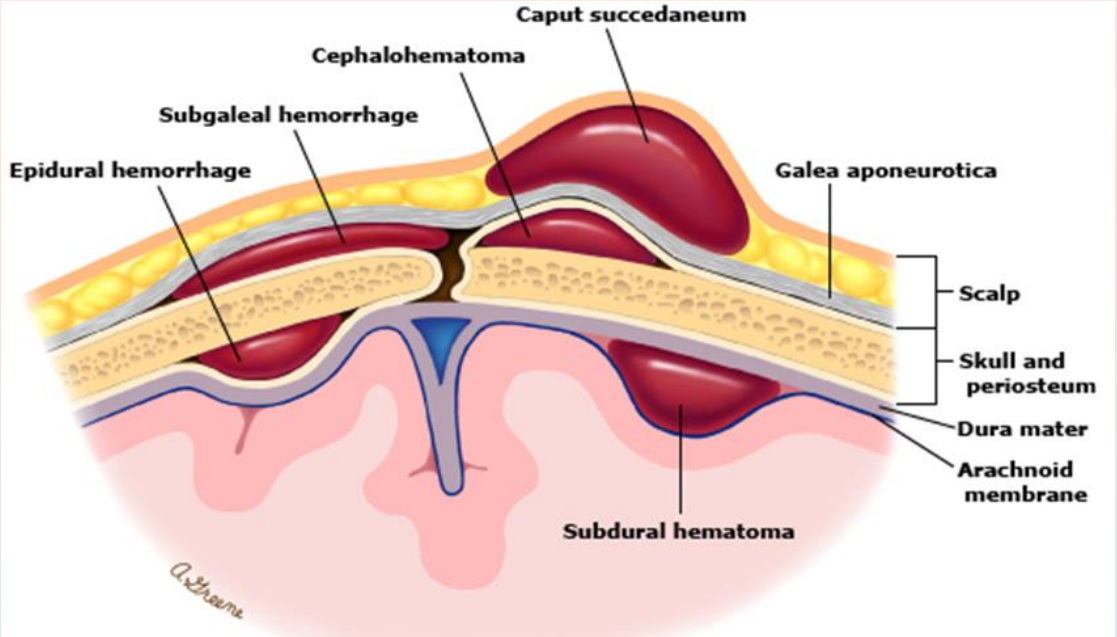
Head

- Shape and symmetry
- Scalp eg. trauma during delivery (microcephaly (<2nd percentile)/macrocephaly (>98th percentile), cephalohaematoma
- Sutures (fused sutures)/ craniosynostosis
- Scalp lesions/swelling/bruising/lacerations



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Musculoskeletal System

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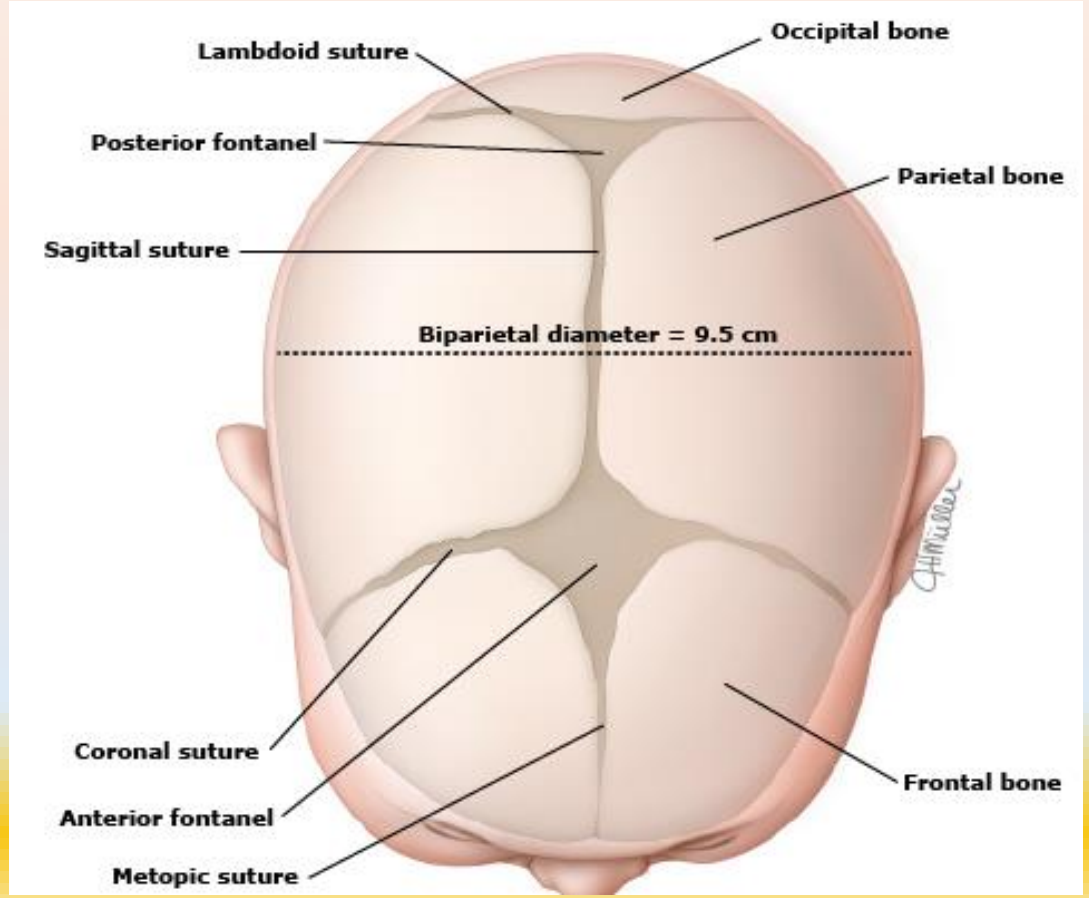
Head - Fontanelles:

Fontanelles are the soft spots on a newborn's skull where the bones have not yet fused. They allow for flexibility during childbirth and accommodate rapid brain growth during infancy. Normally, they are soft and flat

- **Anterior fontanelle:** diamond shaped, at the intersection of four fetal skull bones, and usually **the larger** fontanelle. It typically closes between 12 to 18 months of age.
- **Posterior fontanelle:** triangular, at the intersection of three fetal skull bones, and usually **the smaller** fontanelle. It closes by 2 to 3 months of age.



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Musculoskeletal System

Face:

- Symmetry of structure, features and movement of:
  - Eyes: size and structure, position in relation to the nasal bridge, response to light, leukocoria, eye movements are not coordinated normally
  - Nose: nares and septum, nasal passages
  - Mouth: gums and teeth, lips, palate-hard and soft-, tongue and frenulum, throat
  - Ears: well-formed cartilage, tympanic membranes with an otoscope
  - Jaw
  - Neck: thyroid gland or other masses, bones across the upper chest (clavicles)

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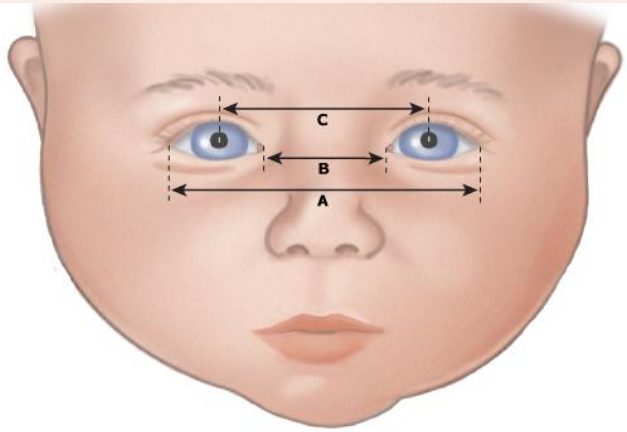
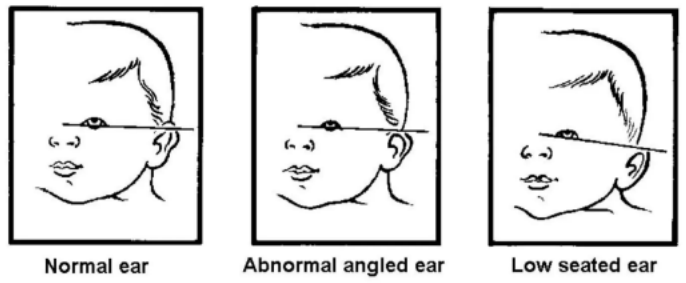


Distance between the eyes should be measured in newborn infants if the eye spacing appears abnormal. The standard values for the newborn include:

Arrow A. Outer canthal distance ranges from 5.2 to 7.3 cm (2 to 2.9 inches).

Arrow B. Inner canthal distance ranges from 1.5 to 2.55 cm (0.6 to 1 inch).

Arrow C. Interpupillary distance ranges from 3.25 to 4.5 cm (1.3 to 1.8 inches).



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Musculoskeletal System

Hips, legs, and feet:

- Use Barlow and Ortolani manoeuvres to examine for hip dysplasia: typically performed in the first 2-4 weeks of life
- Symmetry and leg length
- Movement
- Structure and number of digits

VIRTUAL CHILDREN'S HOSPITAL FOR LEARNING PEDIATRIC NURSING

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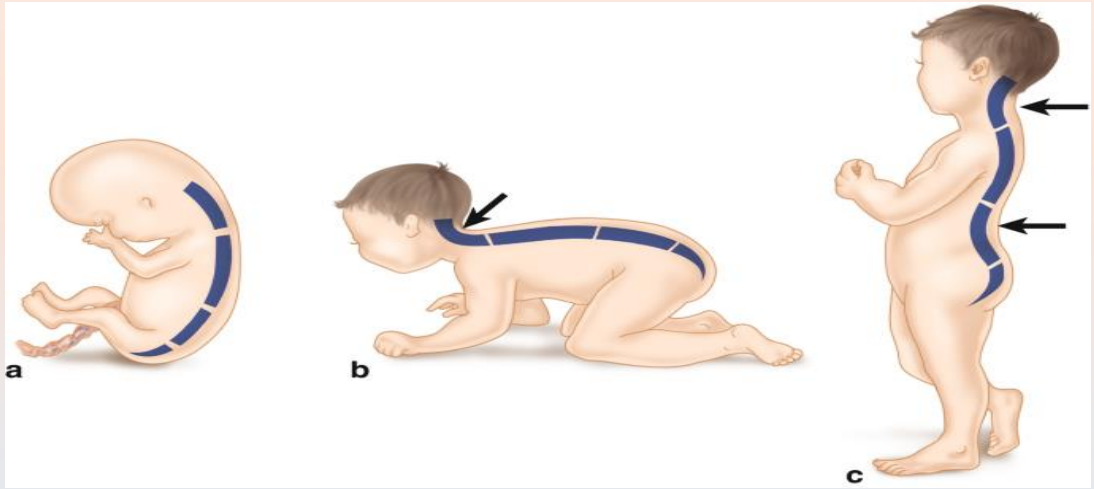
Musculoskeletal System

Back:

- Spinal column symmetry
- Sacral hair tufts: are usually dense, dark, patch or tufts, localized over the sacrum. It is a sign of spinal abnormalities
- Sinus tracts or masses
- Symmetry of scapulae and buttocks



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Musculoskeletal System

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- A newborn has approximately 270 bones at birth. Over time, some of these bones fuse together, resulting in 206 bones in adulthood.
- The spinal column of a newborn has a single curve (primary curvature) resembling a C-shape. As the child grows and begins to hold its head up and sit, secondary curves develop (cervical and lumbar lordosis).
- Newborns possess a significant amount of muscle mass relative to their body size and they lacks the ability to actively control posture. As they grow, they begin to develop muscle strength and balance, leading to the ability to roll over, sit, crawl, and eventually walk.

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Integumentary System (Skin)

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- **Colour:** abnormal - central cyanosis, pallor, yellow
- **Temperature:** can be taken from the groin or axilla. Newborns have a relatively thin layer of subcutaneous fat, making their bodies less insulated compared to adults. This can make them more sensitive to temperature changes. Newborns are less capable of regulating their body temperature effectively due to their immature integumentary system and lower stores of subcutaneous fat.
  - Normal: 36.5-37.5
  - Hypothermia: <36
  - Hyperthermia: >41

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Integumentary System (Skin)

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- **Trauma or irritation:** the skin of a newborn is thinner and more delicate than that of older children and adults. The epidermis and dermis layers are less developed, making the skin more susceptible to injury and irritation e.g. rashes such as milia, miliaria, nappy rash
- **Congenital or subcutaneous skin lesions:**
  - Mongolian spot
  - Haemangioma: it can be multiple, on nose or forehead, over spine
- **Oedema:** the skin of newborns has higher water content but is more prone to dehydration due to its increased permeability.
- Nails

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Integumentary System (Skin)

- Newborns are often covered in vernix caseosa, a white, creamy substance that protects the skin while in the womb. This substance helps to moisturize the skin and has antimicrobial properties.
- The skin acts as a barrier to protect against pathogens, but in newborns, this barrier function is still developing. Due to the thinness of the skin, it is more permeable, increasing the risk of absorption of topical substances and sensitivity to irritants.
- Newborn skin typically has a higher pH at birth, often around 6 to 7, which is more neutral. This can be attributed to exposure to amniotic fluid and the lack of keratinization and sebaceous gland activity in the early days of life.

Age Group	Skin pH Range
Neonates	6.0 - 7.0
Children	5.0 - 5.5
Adults	4.5 - 5.5

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Discharge Assessment

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- **Observations:** stable vital signs, normal output (urine, stools)
- **Feeding:** good feeding pattern, gaining weight, maintaining hydration
- **Vitamin K:** given soon after birth to prevent hemorrhagic disease
- **Parental education and support:** breastfeeding, discuss issues regarding routine screening tests, childhood immunization program, newborn care, medications, referral and follow-up

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