

Brain Injury during Fetal-Neonatal Transition

**Adre du Plessis, MBChB
Fetal and Transitional Medicine
Children's National Medical Center
Washington, DC**

Brain injury during fetal-neonatal transition

- Injury resulting during abnormal transition from fetal to stable neonatal physiology
- Pathophysiologies include
 - Compromised compensatory mechanisms
 - Immature anatomy / physiology
 - Abnormal systemic / cerebral circulation
- Focus will be on cerebral hypoxia-ischemia /reperfusion injury

Hypoxia-ischemia/reperfusion brain injury in the full-term infant

Systemic hypoxia-ischemia/reperfusion

- **Transient severe asphyxia**
- **Prolonged partial asphyxia**

Regional cerebral hypoxia-ischemia/reperfusion

Focal cerebral hypoxia-ischemia/reperfusion

- **Arterio-occlusive insults ('stroke')**
- **Veno-occlusive insults**

Definition of Perinatal Asphyxia

- **Perinatal asphyxia is an acquired metabolic condition that results when gas exchange is impaired between the maternal and fetal circulations, or in the early newborn period**
- **The initial effects are a decrease in circulating arterial oxygen (hypoxemia) and an accumulation of circulating carbon dioxide (hypercarbia) causing fetal respiratory acidosis**
- **If fetal hypoxemia is sustained, tissue oxygen levels begin to fall (hypoxia), and the anaerobic metabolism that ensues leads to lactate accumulation, metabolic acidosis, and eventual energy failure**

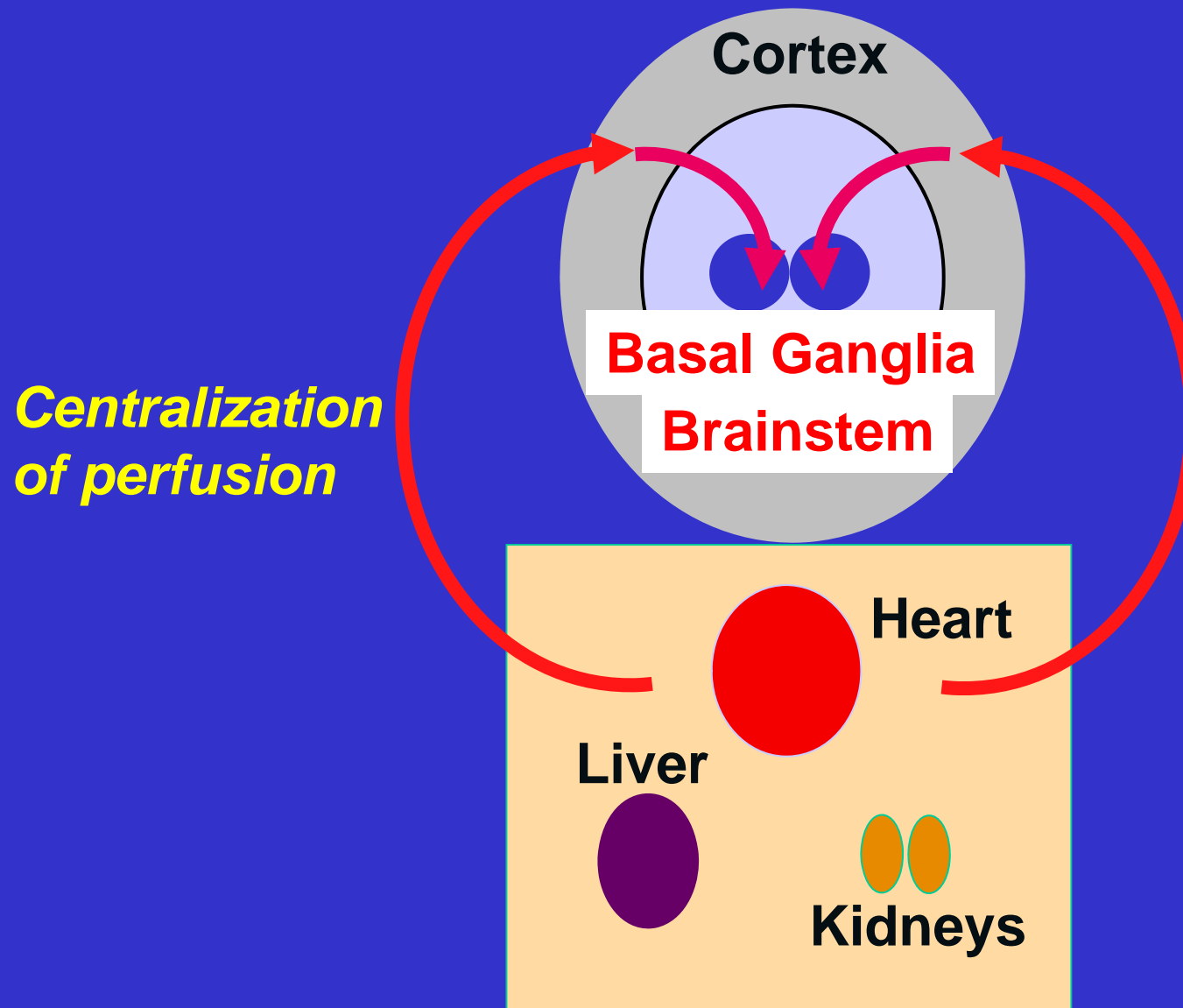
Systemic fetal hypoxia-ischemia/reperfusion

1. Prolonged partial asphyxia

- Placental failure with prolonged labor
- Tetanic uterine contractions
- Nuchal cord

Systemic fetal hypoxia-ischemia/reperfusion

1. Partial Prolonged Fetal Hypoxia

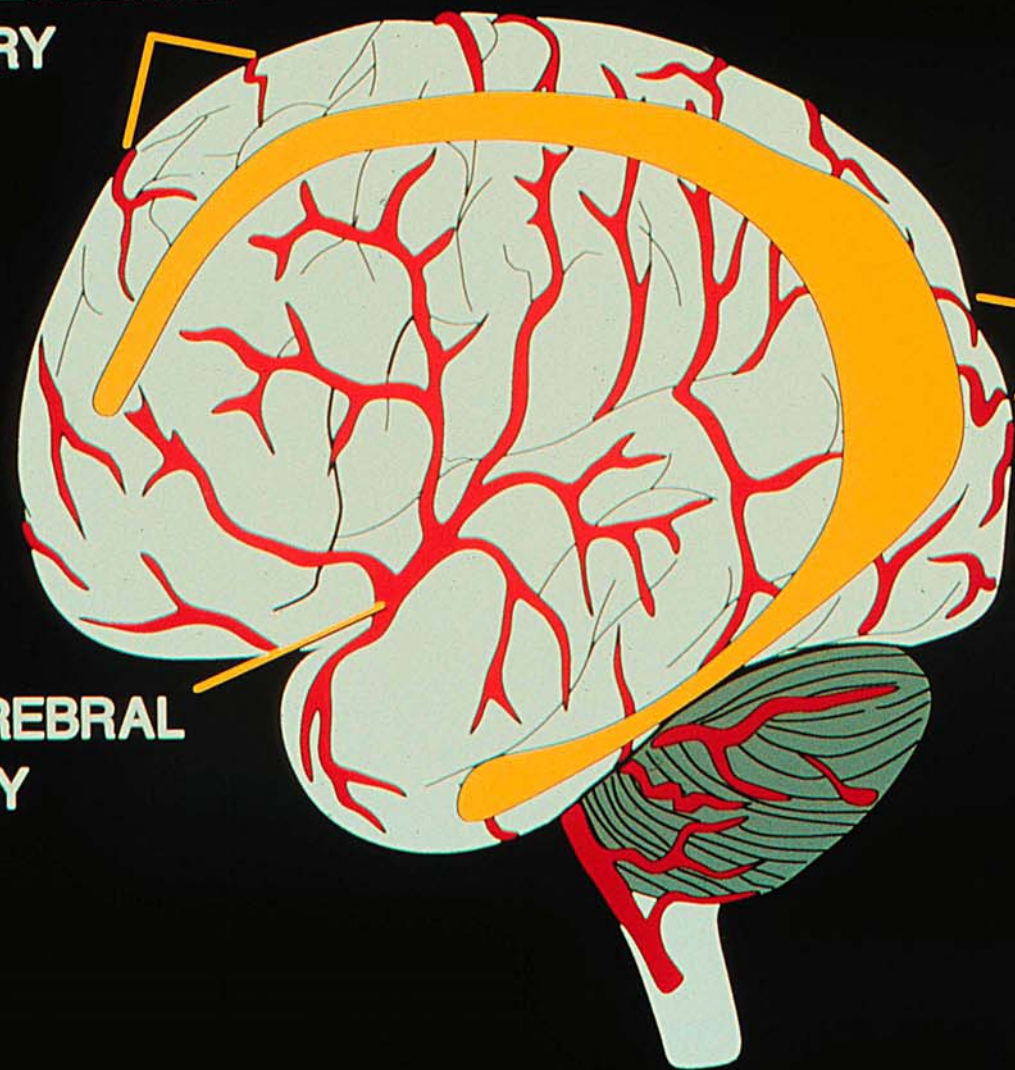


Major Cerebral Arterial Supply Territories

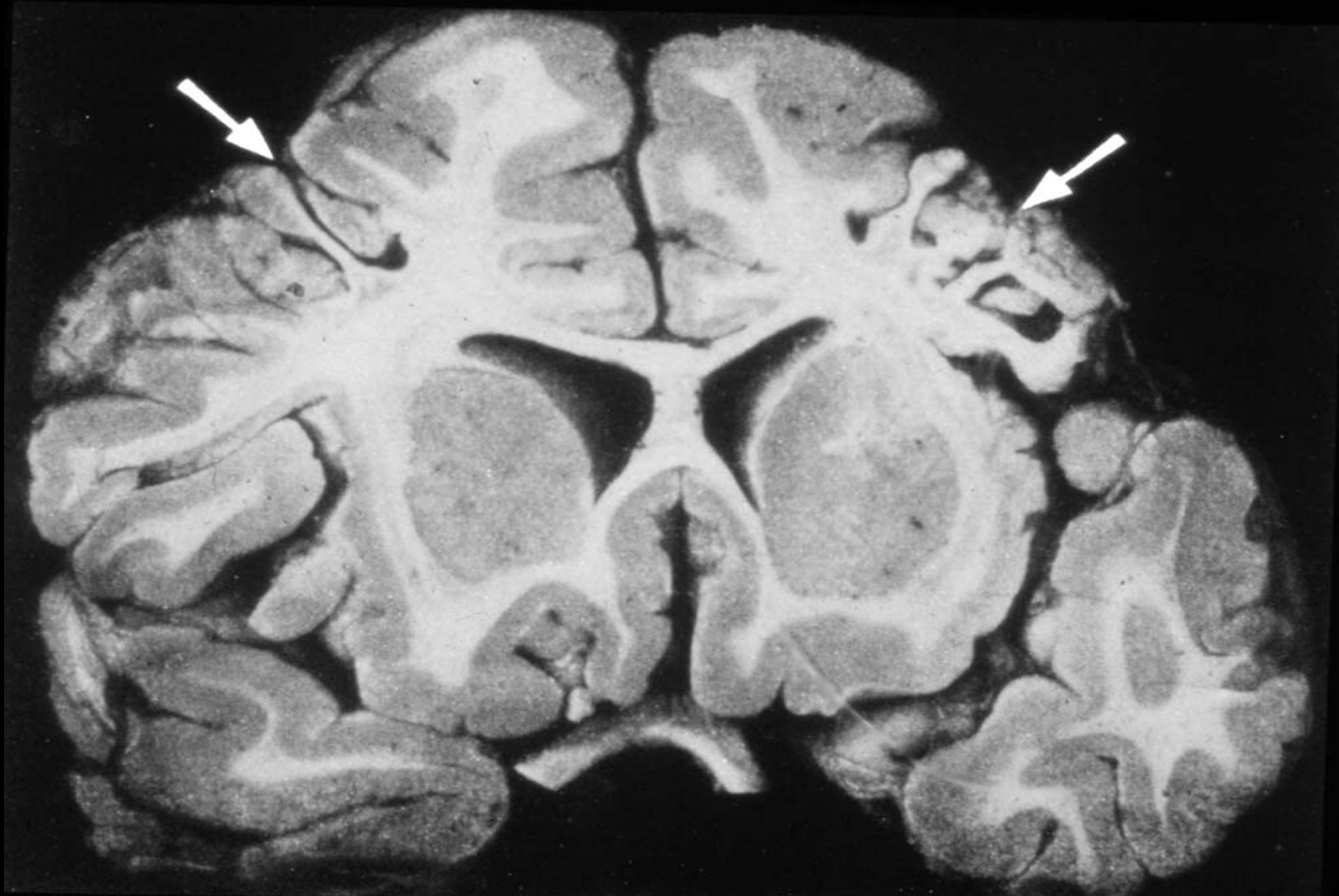
**ANTERIOR CEREBRAL
ARTERY**

**POSTERIOR
CEREBRAL
ARTERY**

**MIDDLE CEREBRAL
ARTERY**



Prolonged Partial Insult Parasagittal Injury



Prolonged Partial Asphyxia

“Circulatory centralization” eventually collapses when

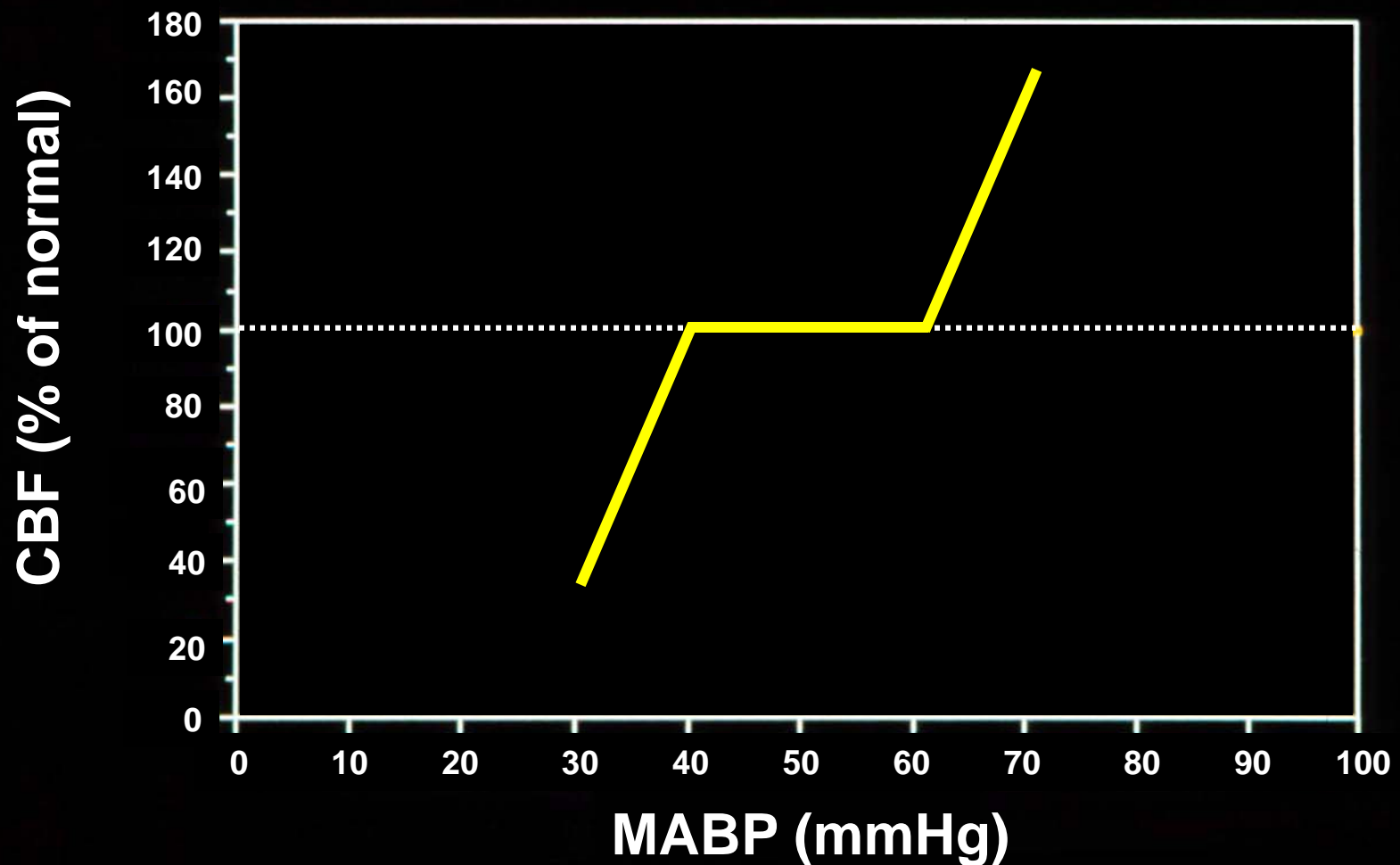
- tissue lactate accumulation causes vasodilation, overriding adrenergic vasoconstriction
- myocardial lactate accumulation and glycogen depletion causes hypotension

Cerebral pressure autoregulation fails with progressive hypoxemia and hypercarbia

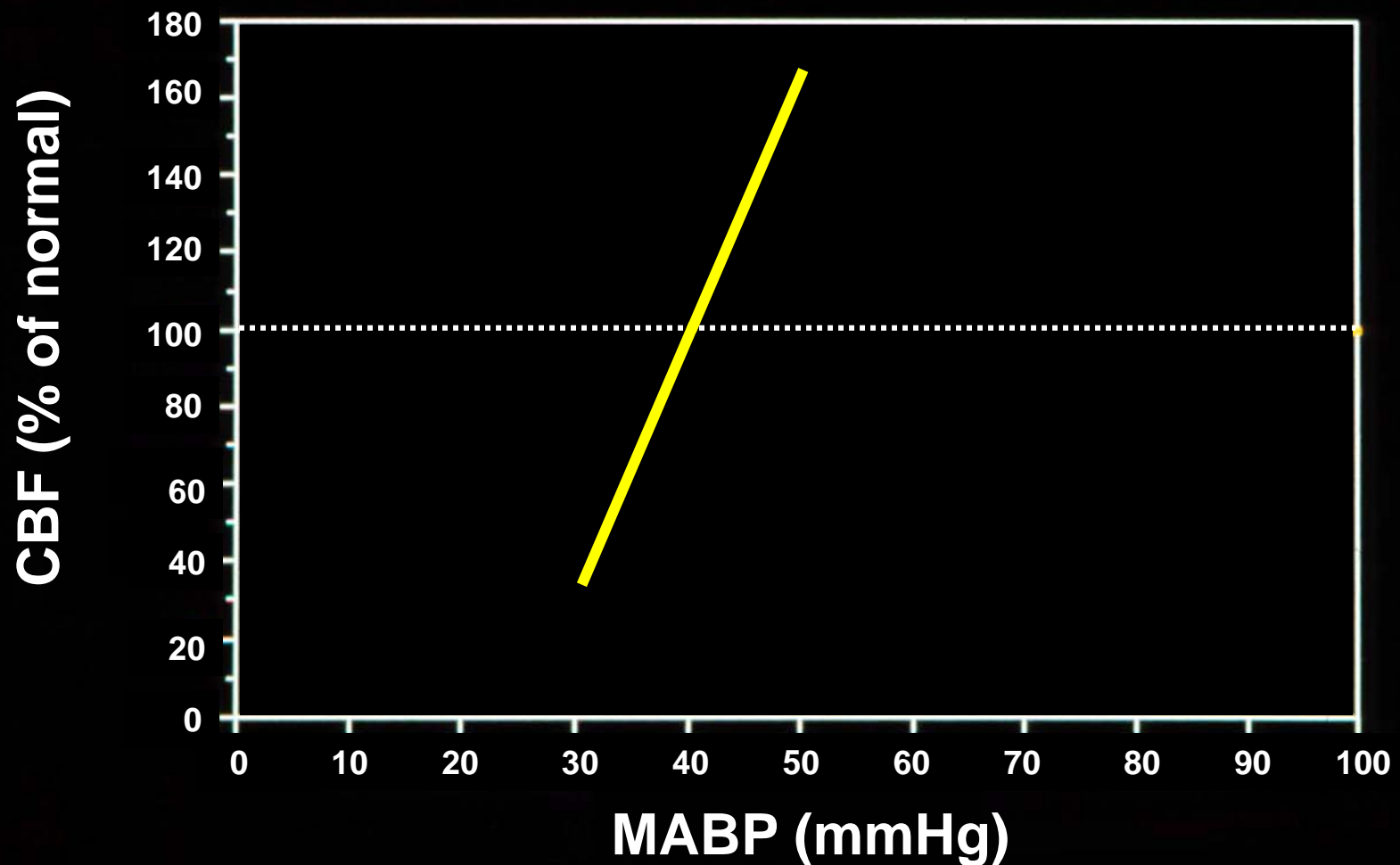
Hypotension and pressure-passive cerebral circulation cause serious cerebral circulatory insufficiency

Systemic end organ injury prominent; often severe acidosis

Fetal asphyxia causes sustained disruption of cerebral pressure autoregulation



Fetal asphyxia causes sustained disruption of cerebral pressure autoregulation



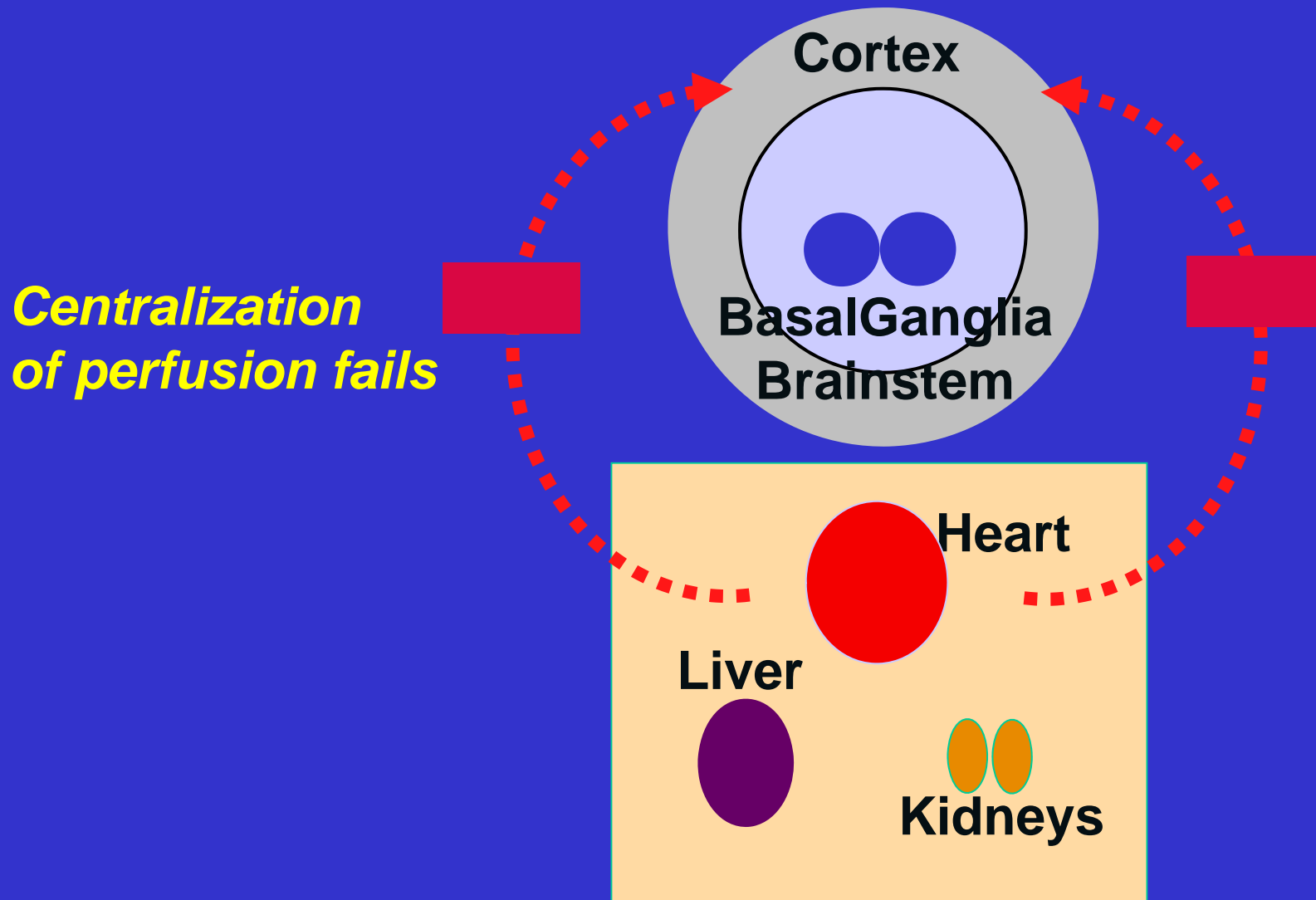
Systemic fetal hypoxia-ischemia/reperfusion

2. Transient severe asphyxia

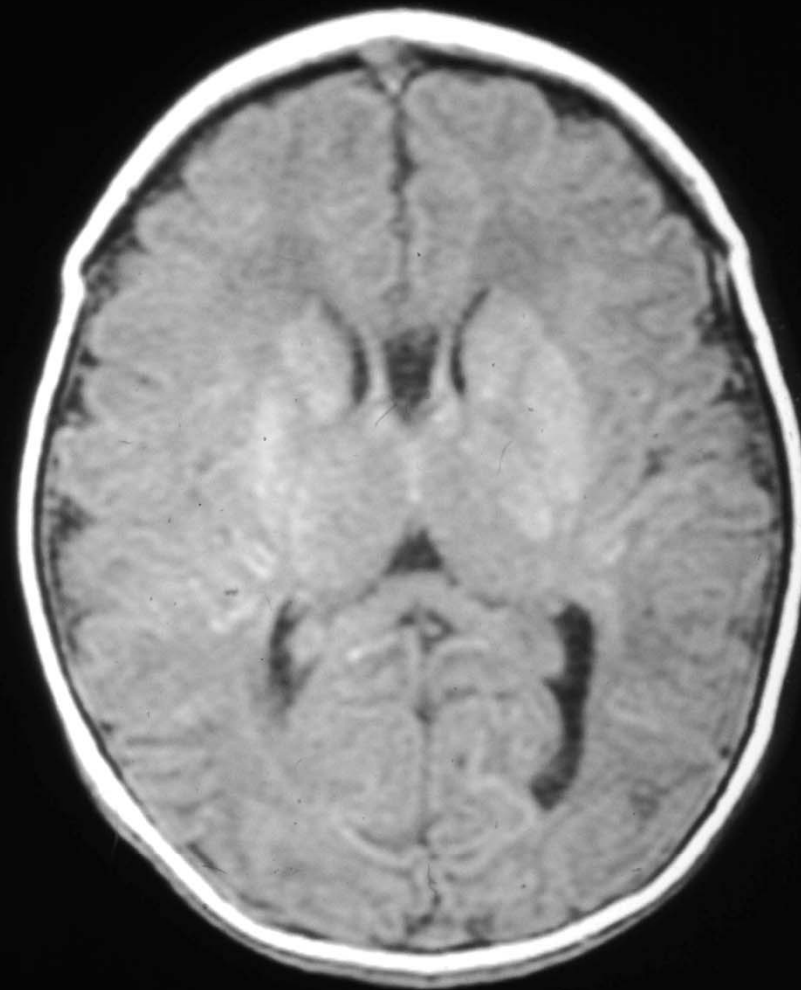
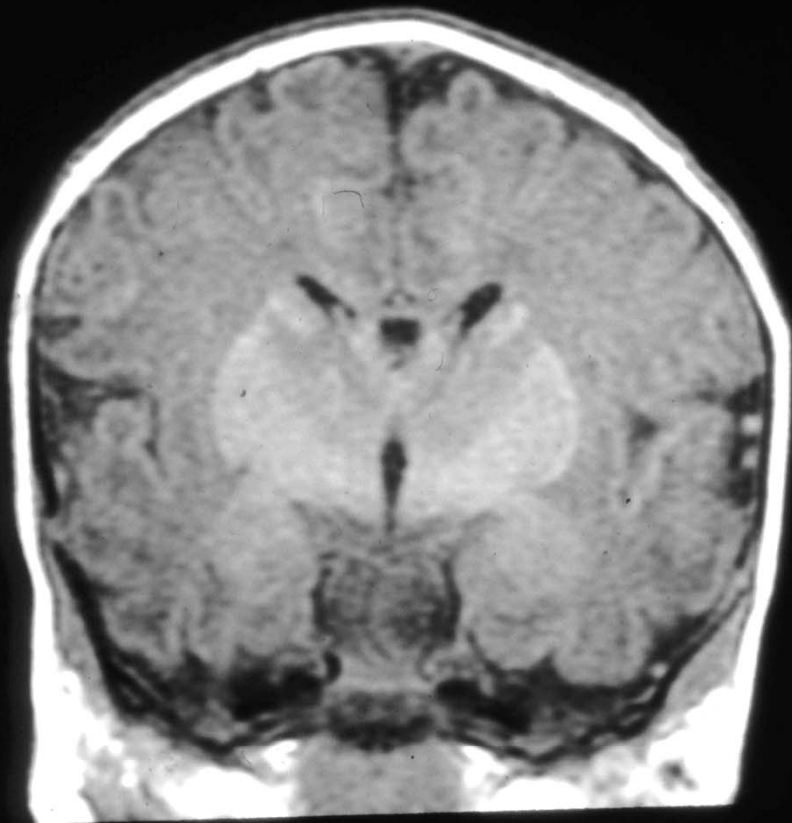
- Uterine rupture
- Placental abruption
- Cord prolapse

Systemic fetal hypoxia-ischemia/reperfusion

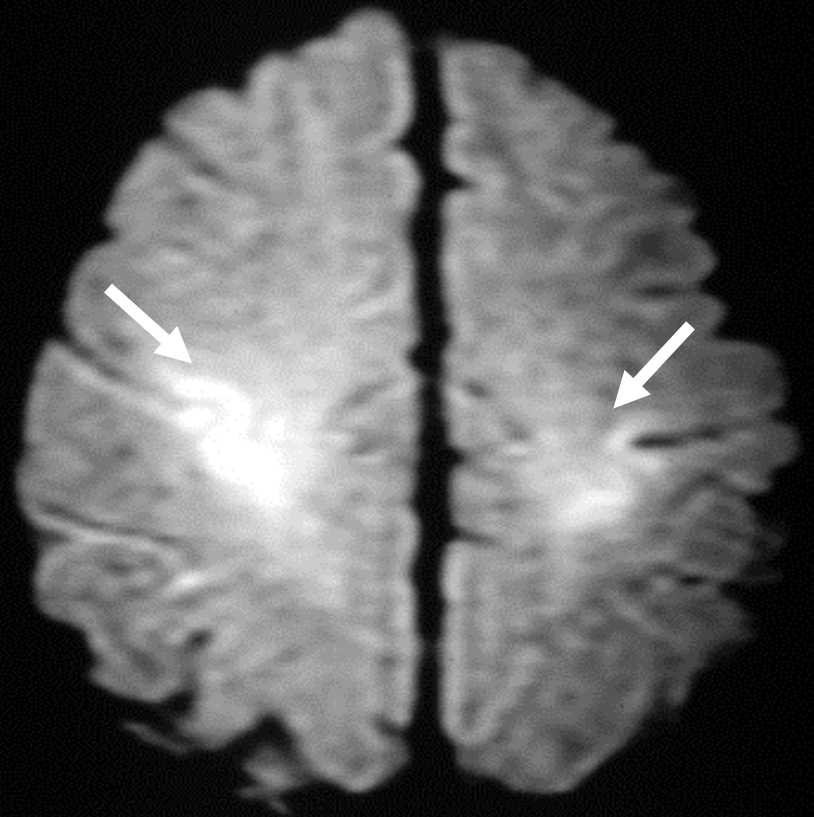
2. Transient Severe Fetal Hypoxia



Transient severe fetal hypoxia



**Transient severe asphyxia
Basal ganglia-thalamic injury**



Transient Severe Perinatal Asphyxia

- Topography of brain injury
 - Basal ganglia : putaminal
 - Thalamus : dorsolateral
 - Brainstem : dorsal
 - Cerebral : sensorimotor gray / white
- Systemic end organ injury may be mild-absent
- Cord blood gases may *not* show severe acidosis

Regional cerebral intrapartum hypoperfusion

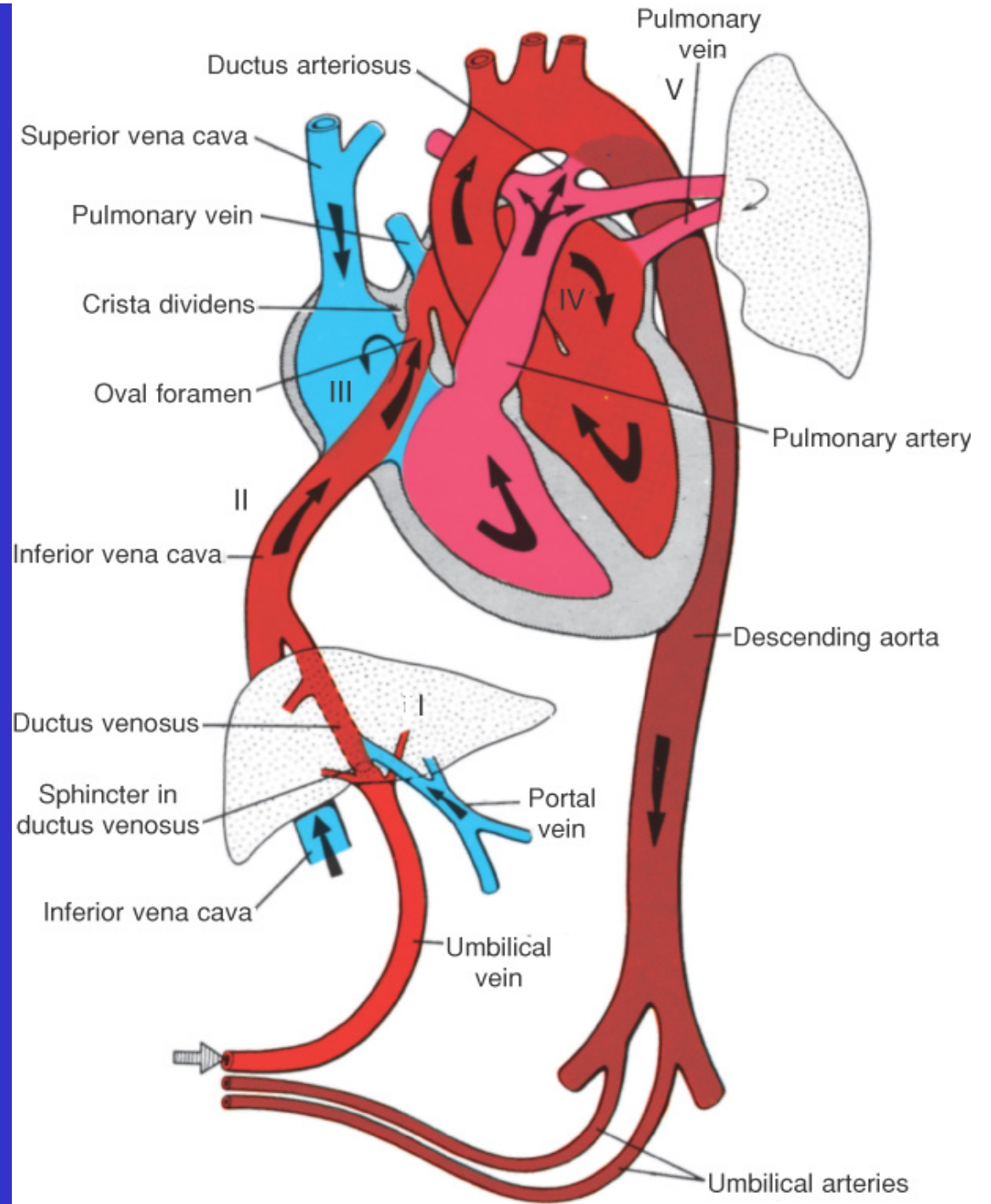
- Prolonged obstructed labor with cranial compression
- Shoulder dystocia
- Pattern of injury resembles prolonged partial HI/R but has additional features of venous ischemia and hemorrhage

Focal cerebral hypoxia-ischemia/reperfusion

Neonatal arterial stroke

- Etiology often unclear
- ? Role of transitional circulation

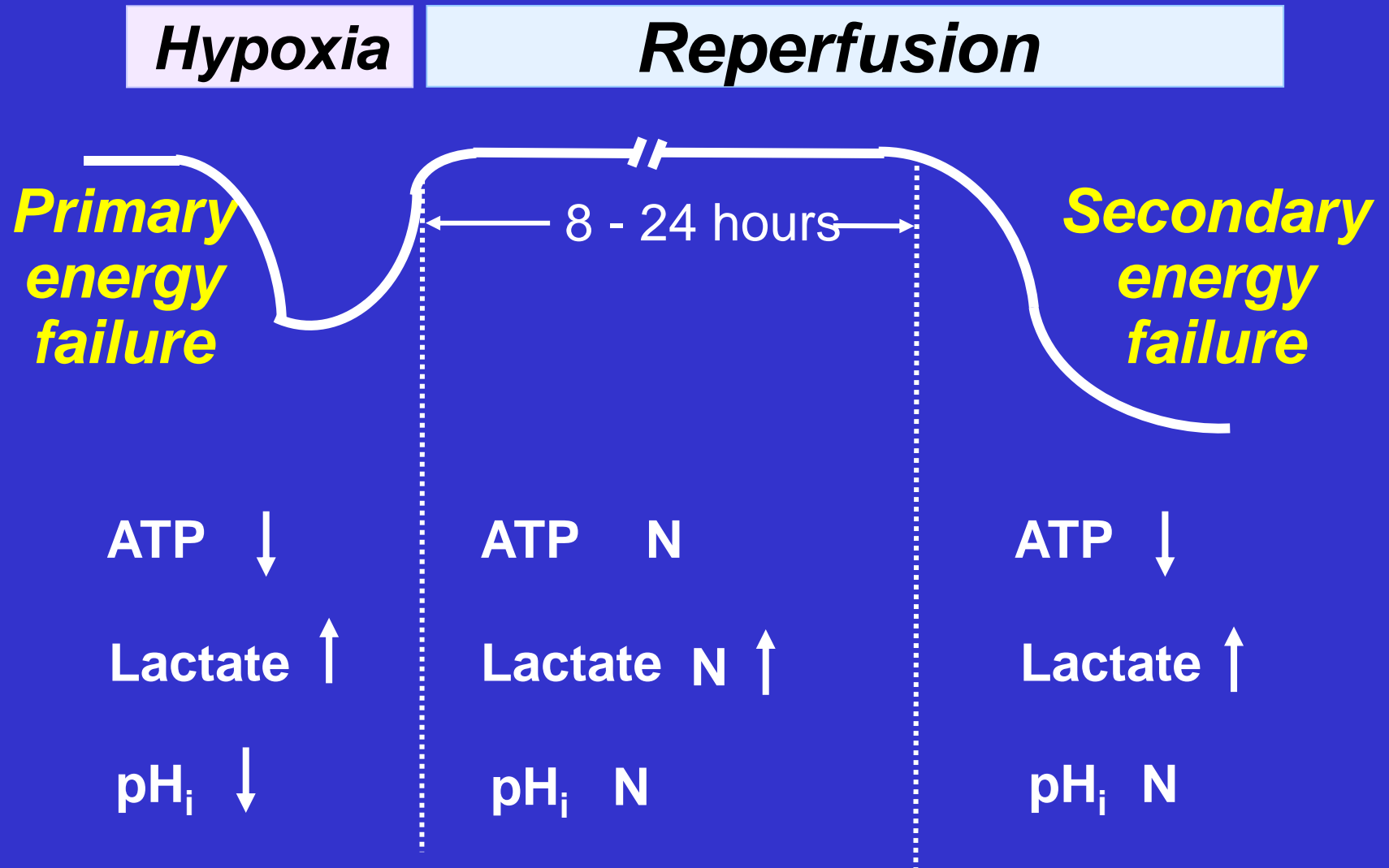
Fetal-transitional circulation



Importance of timing of injury

- Increasingly important for management (therapeutic windows)
- Medicolegal issues

Phases of cerebral energy failure



Ongoing challenges for the management of perinatal brain injury

Establishing the

- Severity of the initial insult
- The nature of the insult
- The timing of the insult
- The acute response to treatment

Summary and conclusions