The Corpus Callosum
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Major Events in Embryogenesis of the Brain
- Dorsal Induction
- Ventral Induction
- Proliferation
- Migration
- Organization
- Myelination

Dorsal Induction-Neurulation
- Time: 3-4 weeks
- Major events:
  - Neural tube formation
  - Arteries/neuroepithelia closure
  - Proiorior neuroepithelia closure
- Disorders:
  - Cranioradioricis telalis
  - Anencephaly/neuroepiphisis chiasm
  - Myelodysplasia/neurogynoplastic

Neurulation
- Neural Placode
- Neural groove
- Neural Tube
- Spinal cord/brain

Multi Gene Closure of the Neural Tube
- At least 5 genes identified
- Most lesions at junction of two gene domains
- Three of the genes utilize folate as a cofactor in their function
- Molecular genetics of the genes is obscure

Anencephaly
- Defects of Gene 2 and 4 of neural tube closure
- Incompatible with prolonged survival
- "donor tissue?"
Ventral Induction

- Time:
  - 56 weeks
- Major events:
  - Fundus / mesoderm intrusion (Face)
- Disorders:
  - Hypopituitarism, single central venetices with microcephaly

10 Month-old Female

- Hypotelorism
- Microcephaly
- Large ears?
- Marked developmental delay
- Seizures
- Brain malformation?

E. M. Coronal T-2

- Fused thalami, absent inferior vermis, separate temporal horns

Proliferation

- Time:
  - 2-4 months
- Major events:
  - Neuronal and glial proliferation in periventricular zone
- Disorders:
  - Microcephaly vars
    - Apparently well formed, small brain
  - Megalencephaly
    - Apparently well formed large brain.

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Macrencephaly
- Brains larger than normal but not functionally organized
- Normally due to overgrowth, lack of apoptosis etc.

Microcephaly Vera
- Normal morphologically, the brain is smaller than usual
  with fewer neurons and/or fewer neuronal columns

Migration Phase
- Time:
  - 3-5 months
- Major events:
  - Migration of glial and neural elements from periventricular area to
    cortex
  - Formation of grey matter cortex and corpus callosum
- Disorders:
  - Solitocencephaly
  - Lissencephaly
  - Pachygyria, polymicrogyria, heterotopia
  - Agenesia and hypoplasia of the Corpus Callosum?

Development of complexity of neuronal network depends
on the establishment of connections as later migrating neurons pass
earlier migrating neurons.

Migration of Neurons
- Gial guiding critical for normal neuronal migration
- Gial cells migrate first
- Many more cells migrate than will reside finally in
cortex
- Neurons establish connections as they migrate
  through the superficial layers
**Schizencephaly**

Open lipped: schizencephaly
And closed lipped schizencephaly depending on degree of gray matter cover over the cleft.

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**Polymicrogyria**

- Most frequently at tip of the Sylvian fissure
- Many causes but prenatal in origin most commonly

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**Organization**

- **Time:**
  - 6 months gestation to 6-8 months of life
- **Major events:**
  - Demolitic, Purkinje and Axonal arborization
  - Selective cell death and glial proliferation
- **Disorders:**
  - Learning processing difficulties
  - Mental retardation with normal gross brain structures

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**Development of the Brain**

- Prosencephalic formation
- Concurrently with ventral induction beginning at about 6 weeks of gestation and proceeding from there.

**Prosencephalic (Forebrain) formation**

- Prosencephalic cleavage
  - Horizontal – Optic and Olfactory tracts
  - Transverse – Telencephalon / Diencephalon
  - Sagittal – cerebral hemispheres, basal ganglia, ventricles
- Midline Prosencephalic development
  - Corpus callosum
  - Septum pelliculare
  - Optic chiasma
  - Hypothalamus

**Disorders of Prosencephalic Development**

- Prosencephalic formation
  - Anencephaly / Meningoencephaly (amniosophaly)
- Prosencephalic cleavage
  - Holoprosencephaly / Holomeerescephaaly
- Midline prosencephalic development
  - Agenesis of the corpus callosum
  - Absent septum pellucidum / cingulum pellucidum?
  - Optic nerve / chiasma defects

**Disorders of Midline Prosencephalic Development**

- Commissural plate
  - Corpus callosum
  - Septum pellucidum
- Chiasmatic plate
  - Optic chiasma, Septo-optic dysplasia
- Hypothalamic primordium
  - Septo-optic dysplasia with hypothalamic dysfunction
  - Growth failure, abnormal maturation, salt and water etc.
Anatomy of the Corpus Callosum
- Major structure containing fiber tracts from one hemisphere to the other
- Narrow variation in size relative to size of the brain
- Thinner in size between 11 and 13 years, then constant in size relative to brain

Anomalies of the CC
A. Normal CC
B. Absent CC (agenesis)
C. Partial absence of CC, also has Chiari II malformation of brain
D. Hypoplastic CC, Thinner than normal due to decreased numbers of crossing fibers

Anomalies of the CC
- Absence of CC
  - May occur as an isolated event (Dextrohomolaterality)
  - Remainder of brain may have developed normally
  - May occur as a part of more widespread malformational syndromes
- Partial absence of CC
  - Usually the result of disturbance of development in "mid streams"
  - The abnormal influence may and usually does affect other areas of the brain also
- Hypoplastic CC
  - Diminished numbers of crossing fibers resulting in thin CC
  - Can be the result of extensive white matter destruction
  - More likely the result of global developmental disturbance

Colpocephaly in ACC
- Disproportionate dilatation of the posterior horns of the lateral ventricles
- Preservation of the normal configuration of the lateral ventricles (Yakovlev 1940)
- Deficient development of the posterior cerebral white matter

Absence of the Septum Pellucidum
- Recto-Orbito-dysplasia
- Visual function often impaired
- Endocrine function often impaired
- Cognitive function often impaired
- Behavior frequent
- Salt and water regulation frequently impaired

Agenesis of the CC With Colpocephaly

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Infantile Seizures
- Delay in development
- Hypotonia
- Poor head control
- No specific facial features

Microphthalmia With Coloboma
- These features constitute the features of a disease known as Aicardi syndrome.
- Malign defects of brain including cerebrum and cerebellum and optic nerve

Aicardi Syndrome
- Most common presentation is with Infantile Spasms
- Females affected
- Xp22
- X-linked dominant
- Lethal in males
- Gone not yet identified
- All cases represent new mutations
- Influence of paternal age

Chiari II Malformation
- Abnormal "line" of mesencephalon
- Beaked quadrigeminal plate
- Cardiac tumors herniated to the cervical spinal canal
- Syringomyelia
- Associated with WM (dorsal induction defect)

Syringomyelia
- Chiari I
- Chiari II
- Other malformations of the cord

7 Year-old female
- Hypertelorism, Apparent and real
- Broad bridge of nose
- Low hair line
- Short neck
- Low-set malformed ears
Dysmorphic features

- Flat nose
- Protruding jaw
- Low set ears
- Low hair line
  - Particularly posterior

Agenesis of the Corpus callosum

- Median Facial Cleft syndrome
- Also seen with other malformation syndromes
  - CATCH 22 syndromes
  - CHARGE
  - Many others

10 Year-old with Heart lesions and developmental delay

- Narrow face
- Prominent bridge of nose
- ABD. VSD, Conotruncal heart lesion
- High narrow palate
- Growth failure

CATCH 22 Spectrum
- Shprintzen syndrome
- DiGeorge, ACF etc.

MRI of a Child With Developmental Delay

Shprintzen's Syndrome

- Brain anomalies
  - Colpocephaly
  - Heterotopias
  - Hypoplastic CC
  - Agenesis of CC
  - Hypothalamic anomalies
  - Chiasmatic anomalies
  - Atrophy
  - Small Posterior fossa

A-CC with Midline Cyst

- Lipoma and cyst formation common with interruption of the CC development
- May develop in conjunction with the CC or may develop instead of the CC or may be the result of tissue loss or injury during the development of the CC
A-CC
- Agenesis of the corpus callosum
- Midline arachnoid cyst formation and
- Entrainment of the left lateral ventricle and
  unilateral hypoplasia
- Note migrational
  abnormality of left frontal lobe grey matter

Lipoma of CC

Lipoma of CC

9 Y-O Large head
Dymorphic, ataxic

Dandy-Walker
- Agenesis of the Corpus Callosum
- Cystic dilatation of the 4th
  ventricle
- Absence of the cerebellar
  vermis (malformation)

8 Year Old Girl
- In regular class
- LD teacher aide
- School picture

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