

Biological Psych

Human Brain Development

Prenatal

18 days after conception

Primitive streak

Outer layer of embryo thickens

Ectoderm forms a plate

Edges curl up

Make a neural tube

Cells inside tube

Become neurons & glial cells

Closed tube

Tube with 3 bulges

Quick Preview

1. Forebrain

Cerebral cortex

Basal ganglia

Limbic system

Thalamus

Hypothalamus

2. Midbrain

Superior colliculi = vision

Inferior collicui = hearing

Homeostasis & reflexes

3. Hindbrain

Medulla oblongata

Cerebellum

Pons

PHASES

1st Phase

Symmetrical Division

2 identical founder cells

Radial Glial Cells

Spread out like tree

Neurons climb tree to their proper position

2nd Phase

Asymmetrical Division

About 3 months

Divide into neuron & founder cells

End of cortical development
founder cells receive signal (cell death)

Connections

When neurons reach home

Connect with each other
Grow dendrites & axons
Synapse formation
Synapse elimination

5 Steps of Neurons

1. Proliferation

Production of new cells
Cells along the ventricles divide to become neurons and glia.

2. Migration

Primitive neurons find their spots
Chemicals guide cells

3. Differentiation

Neurons get axon & dendrites
Makes them different
Axon grow before dendrites
During migration

4. Myelination

Glia cells produce myelin sheaths
first in spinal cord
Then in brain
Lasts til about 30

5. Synaptogenesis

Continues throughout life
Forming synapses

Age & Neurons

Neurons go from
undifferentiated
differentiated
dead

Stem cells

Nose cells always undifferentiated
Periodically divide & make new olfactory cells

Pathfinding

Getting axons to their spots
Chemical Pathfinding (Weiss, 1924)
Grafted extra leg to a salamander

Axons grew, moved in sync with other legs
Nerves attach to muscles randomly
Variety of messages are sent
Each one tuned to a dif. muscle

Chemical Gradients (Sperry, 1943)

Severed optic nerve axons
Rotated them 180°
Grow back to their original target locations in midbrain
Axons attracted by some chemicals, repelled by others
TOPDV protein is 30x more concentrated in dorsal retina than ventral retina axons
Highest connect to highest
Lowest concentration axons connect to lowest

Neural Darwinism

During development

Synapses form randomly
Selection process keeps some and rejects others
Chemical guidance
Neurotrophic factors

Muscles & synapse survival

produce & release NGF (nerve growth factor)
Not enough NGF, axons degenerate and cell bodies die

Neurons automatically die

don't make synaptic connection
Apoptosis = cell death

Similar to NGF

Neurotrophin
promotes survival & activity
BDNF
brain-derived neurotrophic factor
most abundant neurotrophin in cortex

Make more than enough

Neurotrophins are also used in adult brains

More axon & dendrite branching
Deficiencies of neurotrophins lead to cortical shrinking and brain diseases

Developing brain vulnerable

Toxic chemicals
Malnutrition
Infections

Teratogens

Environmental factor

Interfere with development

Medication, drug, alcohol or substance

Disease

Critical Periods

Implantation = common blood supply

Whatever's in mother's blood crosses

10 to 14 days after conception

3.5 to 4.5 weeks

closure of the neural tube

Central nervous system vulnerable throughout pregnancy

3 Major Substances

Alcohol

Phenytoin

Chickenpox

1. Fetal alcohol syndrome

Best known non-genetic cause of mental retardation

(3 in 1,000)

Infant brains are especially sensitive to alcohol

Suppress release of glutamate

brain's main excitatory

neurons receive less excitation and undergo apoptosis

Alcohol broken down more slowly

immature liver

Alcohol levels remain high longer

Worse when born to alcoholic mothers

drink more than four to five drinks/day

No amount of alcohol is safe

2. Phenytoin (or Dilantin)

Anti-convulsive

used to treat epilepsy (seizure disorder)

10% chance of birth defects

Fetal Hydantoin Syndrome

If taken in the first trimester

3. Varicella (chickenpox)

Highly infectious disease

95% of Americans have had it

90% of pregnant women are immune

1 out of 2,000 develop during pregnancy

A. If in pregnancy (week 1-20)

2% chance of defects

"congenital varicella syndrome"

Scars

Malformed and paralyzed limbs

B. Newborn period

5 days before to 2 after birth

About 25 % newborns become infected

About 30% of infected babies will die if not treated

Parental use of:

Cocaine or cigarettes

ADHD

Antidepressant drugs

Heart problems

Birth Defects

3-5% of newborns

Leading cause of infant mortality

Majority have no known cause

Cortex Differentiation

Different parts of cortex, different shapes

Shape and functions depend on input received

Transplant immature neurons

Become like neighbors

Transplant later

Some new, some old attributes

Experience fine tunes

Redesign our brain to fit

(within limits)

Enriched environments

Thicker cortex

More dendritic branching

Best enrichment = activity

Transfer

Far transfer = do well in one, do well in other tasks

Near transfer = practice task, do better on that task only

Train the brain – doesn't work

Blind from birth

Better at discriminating objects by touch

Increased activation in occipital lobe (vision) doing touch tasks
Use occipital cortex for Braille; sighted people don't
Concept of straight

Learning to read

Learn to read as adults
More gray matter in cortex
Thicker corpus callosum

Music Training

Pro musicians

Bigger temporal lobe (30%)
2x greater response to pure tones (in auditory cortex)

Violin players

larger area devoted to left fingers in the postcentral gyrus

Writer's Cramp

Spend all day writing

Fingers get jerky, clumsy & tired

Musician's Cramp

Practice too much

Fingers get jerky, clumsy & tired
Expanded representation of each finger overlaps neighbor

OVERRULING reflexes

Antisaccade task

Object appears in periphery
Must look in opposite direction
Top-down processing overruling reflex
Improves with age unless
Very young
hard to look away from attention getter
ADHD

Age & Neurons

At 30

Frontal cortex begins to thin
Much individual variation

60+

Synapses alter more slowly (learn)
Hippocampus gradually shrinks
Compensate by using more brain areas

Blood-Brain Barrier

(Paul Ehrlich, 1800's)

Injected blue dye into animals

All tissues turned blue EXCEPT brain and spinal cord

Keeps most chemicals out of brain

Why need BBB?

Brain has no immune system

Neurons can't replicate-replaced

No way to fix damage

Viruses that do enter kill you

Rabbies

Neural disorders last whole life

Chicken pox-shingles

How it works

Keeps out harmful chemicals

Keeps out medications

Cancer med

Dopamine for Parkinson's

Astrocytes form layer around brain blood vessels

may be responsible for transporting ions from brain to blood

Semi-permeable

Endothelial cells line capillaries

Small spaces between each

Some things can move between them

Loosely joined in body, large gaps

Tightly joined in brain, blocking most molecules

Large molecules can't easily pass thru

Molecules with a high electrical charge are slowed down

Protects the brain

What can cross passively

Small uncharged molecules

Oxygen & carbon dioxide

Molecules dissolve in fats

capillary walls are fats

What can cross actively

An active transport system

protein-mediated process

uses energy to pump chemicals

E.g., burn glucose for energy

Broken by:

Hypertension (high blood pressure)
Development (not fully formed at birth)
High concentrations of some substances
Microwaves & radiation
Inflammation
Brain injury
Infections

Alzheimer's disease
endothelial cells shrink
makes gaps
harmful chemicals enter

Nourishing Neurons

Almost all need glucose

Practically only nutrient that crosses blood-brain barrier in adults
Ketones can also cross but are in short supply.

If you can't use glucose

Korsakoff's syndrome
thiamine (vitamin B₁) deficiency
inability to use glucose
neuron death
severe memory impairment

Head Injury

Open or Closed

Open head injury (penetrating)
Object enters brain
Closed head injury (skull not broke)
Concussion
Most common traumatic injury
Brain gets rattled

Causes

Car, train, airplane accident
Fall
Assault
Sports

Symptoms

Can show immediately or develop slowly
Unequal pupil size
Headaches
Obvious

Object sticking out of head
Fluid draining from nose-ears
Clear or bloody
Coma or unconscious
Paralysis
Seizures

Sort Of Obvious

Slurred speech
Blurred vision
Lack of coordination
Memory loss
Stiff neck
Vomiting more than once; children often vomit once

Not So Obvious

Irritability (especially children)
Mood or personality changes
Drowsiness
Confusion
Loss of hearing, vision, taste or smell
Low breathing rate
Memory loss
Symptoms improve, then get worse

Get immediate help if

Loss consciousness, even briefly
Severe headache or stiff neck
Vomits more than once
Behaves abnormally
Unusually drowsy

Do

Call 911

Make sure breathing

Assume spinal cord injury

If normal breathing but unconscious
Stabilize head and neck
Hands on both sides of head

If bleeding

Press clean cloth on wound
If soaks through, don't remove it
Put another cloth over it

DO NOT

Don't wash deep head wound

Don't move or shake

Don't remove helmet

Don't pick up child

Don't drink alcohol (48 hours)

If skull fracture

Don't apply pressure to bleeding site

Don't remove debris from wound

No aspirin

Aspirin & ibuprofen can increase risk of bleeding

If vomiting

Roll the head, neck & body as one unit

Sleeping

Wake every 2 to 3 hours, check alertness

ask simple questions: "What is your name?"