The Brain
Older Brain Structures

The **Brainstem** is the oldest part of the brain, beginning where the spinal cord swells and enters the skull. It is responsible for automatic survival functions.
A. Hindbrain/ Brain Stem

The Medulla (muh-DUL-uh) is the base of the brainstem. It controls autonomic functions and relays nerve signals between the brain and spinal cord. 
- respiration
- blood pressure
- heart rate
- reflex (simple automatic behaviors)
- vomiting

What would happen if this part of the brain was damaged?
Reticular Formation is a nerve network in the brainstem that plays an important role in controlling arousal.
Mediating the overall level of consciousness.
What would happen if this part of the brain was damaged?
Hindbrain/Brain Stem

**Pons** – “Bridge” it passes neural information from one brain region to another.
The Hindbrain/ Brainstem

**Cerebellum**
The “little brain” attached to the rear of the brainstem. It helps coordinate voluntary movements and balance.

(Near the ear)
What would happen if this part of the brain was damaged?
Boxer get’s punched near the ear/temple... what happens?
B. Forebrain

The Thalamus [THAL-uh-muss] is the brain’s sensory switchboard, located on top of the brainstem. It directs messages to the sensory areas in the cortex and transmits replies to the cerebellum and medulla.

Receives and directs sensory info from visual and auditory system.
The Limbic System

The **Limbic System** is a doughnut-shaped system of neural structures at the border of the brainstem and cerebrum, associated with **emotions** such as fear, aggression and drives for food and sex. It includes the hippocampus, amygdala, and hypothalamus.
The Limbic System: Hippocampus

Hippocampus

- Involved in processing and integrating memories
- People who have this part of the brain damaged loses the ability to form new memories
  - Anterograde amnesia
The Limbic System: Amygdala

The **Amygdala** [ah-MIG-dah-la] consists of two almond-shaped neural clusters linked to the emotions of fear and anger.

What would happen if this part of the brain was damaged?
The Limbic System: Hypothalamus

The **Hypothalamus** lies below *(hypo)* the thalamus. It directs several maintenance of drives: activities like eating, drinking, body temperature, and control of emotions. **Reward center of the brain!**

It helps govern the **endocrine system** via the **pituitary gland**.
Rats cross an electrified grid for self-stimulation when electrodes are placed in the reward (hypothalamus) center (top picture). When the limbic system is manipulated, a rat will navigate fields or climb up a tree (bottom picture).

https://www.youtube.com/watch?v=de_b7k9kQp0
C. The Cerebral Cortex

The intricate fabric of interconnected neural cells that covers the cerebral hemispheres. It is the body’s ultimate control and information processing center.
Structure of the Cortex

Each brain hemisphere is divided into four lobes that are separated by prominent fissures. These lobes are the frontal lobe (forehead), parietal lobe (top to rear head), occipital lobe (back head) and temporal lobe (side of head).
- **frontal lobe** (forehead) – Higher level thought and reasoning. This includes personality, problem solving, and language formation.

- **parietal lobe** (top to rear head) Somatosensory information, receives information about sensory information from the body

- **occipital lobe** (back head) Visual input

- **temporal lobe** (side of head) auditory center.
Functions of the Cortex

The **Motor Cortex** is the area at the rear of the frontal lobes that control voluntary movements. The **Sensory Cortex** (parietal cortex) receives information from skin surface and sense organs.
Visual Function

The functional MRI scan shows the visual cortex is active as the subject looks at faces.

Courtesy of V.P. Clark, K. Keill, J. Ma., Maisog, S. Courney, L.G. Ungerleider, and J.V. Haxby, National Institute of Mental Health.
Auditory Function

The functional MRI scan shows the auditory cortex is active in patients who hallucinate.
Association Areas

More intelligent animals have increased “uncommitted” or association areas of the cortex.
Broca’s area—speaking words and language.

- Think of the word Boca (mouth)

Wernicke’s area – Understanding words and language
Aphasia is an impairment of language, usually caused by left hemisphere damage either to Broca’s area (impaired speaking) or to Wernicke’s area (impaired understanding).
Damages to the associated areas

- **Alexia** – inability to read
- **Apraxia** – inability to organize movement
- **Agnosia** – difficulty processing sensory input
- **Aphasia** – impairment of language
Specialization & Integration

Brain activity when hearing, seeing, and speaking words

(a) Hearing words (auditory cortex and Wernicke’s area)
(b) Seeing words (visual cortex and angular gyrus)
(c) Speaking words (Broca’s, area and the motor cortex)
III. Hemisphere
Fun with your Hemispheres

- Rotate your dominant hand in one direction while at the same time rotating the opposite foot in the other direction.
  - No problem since controlled by two hemispheres
- Now, rotate your dominant hand in one direction while at the same time rotating the foot on the same side in the other direction.
- https://www.youtube.com/watch?v=lBULNG7NuKk
- Brain games
- https://www.youtube.com/watch?v=spiYUmt7w
- Left vs right
Our brain is divided into two hemispheres. The left hemisphere processes reading, writing, speaking, mathematics, and comprehension skills. In the 1960s, it was termed as the dominant brain.
Hemispheric Specialization

- Corpus Callosum
  - Fibers that connect the two hemispheres
  - Allow close communication between left and right hemisphere
- Each hemisphere appears to specialize in certain functions
  (See Worksheet)
Which face is happier?
Which face was happier?
Right Hemisphere
The Wagner Preference Inventory

- (a) left, logical
- (b) left, verbal
- (c) right, manipulative/spatial
- (d) right, creative
Hemispheric Specialization

People with intact brains also show left-right hemispheric differences in mental abilities.

A number of brain scan studies show normal individuals engage their right brain when completing a perceptual (understanding) task and their left brain when carrying out a linguistic (language) task.
Splitting the Brain

A procedure in which the two hemispheres of the brain are isolated by cutting the connecting fibers (mainly those of the corpus callosum) between them.

Corpus Callosum

Courtesy of Terence Williams, University of Iowa
Split Brain Patients

With the corpus callosum severed, objects (apple) presented in the right visual field can be named. Objects (pencil) in the left visual field cannot.
Divided Consciousness

“Look at the dot.”

Two words separated by a dot are momentarily projected.

“What word did you see?”

or

“Point with your left hand to the word you saw.”
IV. Methods and Tools for Studying the Brain
A brain lesion experimentally destroys brain tissue to study animal behaviors after such destruction.

Hubel (1990)
Microelectrode Techniques

- Very small electrodes inserted into individual neurons
- Used to study activity of a single neuron
Macroelectrode Techniques

- Used to get a picture of overall activity in the brain
- An example is an EEG (Electroencephalogram), which uses electrodes placed on a person’s scalp to measure an amplified recording of the electrical waves sweeping across the brain’s surface.
Structural Imaging

- Can show the structure of the Brain
- Computerized Axial Tomography (CAT-scan)
Structural Imaging

- **Computerized Axial Tomography (CAT-scan)**
  - Uses X-rays to create a 3-dimensional image of the brain
  - CT scans can often show the size and locations of brain abnormalities caused by tumors, blood vessel defects, blood clots, strokes and other problems.
Structural Imaging cont’d

- Magnetic Resonance Imaging (MRI)
  - Uses a magnetic field and radio waves to produce computer-generated images
  - They distinguish among different types of brain tissue.
  - Image shows ventricular enlargement in a schizophrenic patient.
Magnetic Resonance Imaging (MRI)
CT Scan vs. MRI

- CT may be less expensive than MRI. In addition, it is less sensitive to patient movement.
- CT can be performed if you have an implanted medical device of any kind, unlike MRI.
- MRI contrast materials used for image enhancement have very low incidence of side effects.
Functional Imaging  
Shows the brain working (functioning in real time)

**EEG imaging**

- 21 Sensors on the scalp record changes in electrical activity and feed them into a computer. The computer translates them into color and motion on a map of the brain displayed on a television monitor.
Functional Imaging
Shows the brain functioning in real time (movies or series of images)

Positron Emission Tomography (PET) and Single Photon Emission Computed Tomography (SPECT)
- Use radioactive glucose to determine location of greatest brain activity
Functional Imaging

- Functional Magnetic Resonance Imaging (fMRI)
  - Shows function and structure by measuring movement of blood molecules within the brain
  - [Click here](#)  
  - [Click here](#)  
  - [Click here](#)
1. What is the central nervous system?
2. What is the peripheral nervous system?
3. What is the somatic nervous system?
4. What is the autonomic nervous system?
5. What is the difference between sympathetic nervous system and parasympathetic nervous system?
Nervous System

Central Nervous System
- Brain
- Spinal Cord

Peripheral Nervous System
- Motor (Efferent) Neurons
- Sensory (Afferent) Neurons

Autonomic Nervous System
- Sympathetic Nervous System
- Parasympathetic Nervous System

Somatic Nervous System
The Spinal Cord

- Complex cable of nerves that connects brain to rest of the body
- Carries motor impulses from the brain to internal organs and muscles
- Carries sensory information from extremities and internal organs to the brain
- 400,000 people a year in US either partial or complete paralysis.
The Spinal Cord

- The spinal cord controls some protective reflexes.
The Peripheral Nervous System

- Peripheral Nervous System
  - Somatic Nervous System
  - Autonomic Nervous System
    - Sympathetic Division
    - Parasympathetic Division
The Somatic Nervous System

- Consists of neurons that communicate between the body and the brain
- Motor Neurons
  - Neurons that carry messages from the spinal cord or brain to muscles and glands
The Autonomic Nervous System

- Sympathetic division
  - Most active when you are angry, afraid, or aroused
  - Increases heart rate and breathing
  - Stops digestion
  - “Fight-or-flight”
The Autonomic Nervous System

- Parasympathetic division
  - Calms body
  - Produces effects opposite to those of the sympathetic division
  - Reduces heart rate and breathing
  - Restores digestion
  - “Rest and Digest”
The Hypothalamus Has Central Control of the ANS

- The hypothalamus is involved in the coordination of ANS responses
- One section of the hypothalamus seems to control many of the "fight or flight" responses; another section favors "rest and digest" activities
1. Define Plasticity
2. When is our brains most plastic?
3. Why is brain’s plasticity good for those who are blind or deaf?
4. How is plasticity evident after serious damage?
5. Define neurogenesis?
1. Define...
   - Endocrine system
   - Hormones

2. What are the functions of the...
   - Pituitary Gland:
   - Thyroid Gland:
   - Adrenal glands:
   - Pancreas:
The Endocrine System

- Pineal gland
- Pituitary gland
- Parathyroid glands
- Thyroid gland
- Pancreas
- Adrenal glands
- Ovaries
- Testes
The Endocrine System

- Controlled by the Hypothalamus (drives)
- Helps coordinate and integrate complex psychological reactions
- Endocrine glands secrete hormones into the bloodstream
- Hormones are chemical substances (similar in function to neurotransmitters) that help regulate bodily activities.
  - Hormones are released into the bloodstream
The Endocrine System

- **Pituitary gland**
  - Referred to as the "master gland" because it regulates many other glands
  - Influences blood pressure, thirst, contractions of the uterus during childbirth, sexual behavior and interest, body growth etc.

- **Gonads**
  - Ovaries and testes secrete *estrogens and androgens* (testosterone)
  - We know they play a role in development, aggression and sexual drive but don’t have the whole story.

- **Adrenal glands**
  - Secretes hormones in reaction to stress
  - Activates (via epinephrine) the sympathetic nervous system.
The Endocrine System

- **Thyroid gland**
  - Secretes hormones (primarily thyroxin) that control metabolism
    - How alert an energetic or how fat and thin you are
    - Overactive Thyroid can mean insomnia, reduced attention span, agitation
    - Too little thyroxin can mean feeling constantly tired

- **Parathyroid glands**
  - Control levels of calcium and phosphate which in turn controls levels of excitability
The Endocrine System

- **Pineal gland**
  - Secretes melatonin which regulates the sleep-wake cycle
  - Disturbances in melatonin are responsible for “jet lag”

- **Pancreas**
  - Regulates blood-sugar levels
  - Secretes insulin and glucagon
V. Genetics
Behavior Genetics: Predicting Individual Differences

Behavior Geneticists study our differences and weigh the relative effects of heredity and environment.
Heritability

Heritability refers to the extent to which the differences among people are attributable to genes.

What percentage of the difference among people's height can be attributed to their genes?

90%
Animal behavior genetic studies include:

Strain studies

- Intense inbreeding over the course of many generations creates a genetically similar strain.

- Two or more strains are raised at once to determine the extent to which the differences among the two groups are attributable to genes.
Animal behavior genetic studies include Selection Studies.

- If a trait is closely regulated by genes then if animals with trait are interbred with those that don’t, more of their offspring should have the trait than in a normal population.
Genes: Our Codes for Life

Chromosomes containing DNA (deoxyribonucleic acid) are situated in the nucleus of a cell.

- **Nucleus** (the inner area of a cell that houses chromosomes and genes)
- **Chromosome** (threadlike structure made largely of DNA molecules)
- **Cell** (the basic structural unit of a living thing)
Genes: Our Codes for Life

Segments within DNA consist of **genes** that make proteins to determine our development.

**Chromosome**
(threadlike structure made largely of DNA molecules)

**DNA**
(a spiraling, complex molecule containing genes)

**Gene**
(segment of DNA containing the code for a particular protein; determines our individual biological development)
Genome

Genome is the set of complete instructions for making an organism, containing all the genes in that organism. Thus, the human genome makes us human, and the genome for *drosophila* makes it a common house fly.
Dominant Gene – Member of a gene pair that controls the appearance of a certain trait.

Recessive Gene - Member of a gene pair that controls the appearance of a certain trait only if it is with another recessive gene.
Genes 101 cont’d

- Polygenic Inheritance – Process by which several genes interact to produce a certain trait; responsible for our most important traits.
Twin Biology

Studying the effects of heredity and environment on two sets of twins, identical and fraternal, has come in handy.
A number of studies compared identical twins raised separately from birth, or close thereafter, and found numerous similarities.

<table>
<thead>
<tr>
<th>Separated Twins</th>
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<tbody>
<tr>
<td>Personality, Intelligence</td>
</tr>
<tr>
<td>Abilities, Attitudes</td>
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<tr>
<td>Interests, Fears</td>
</tr>
<tr>
<td>Brain Waves, Heart Rate</td>
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</table>
Jim Lewis

- Middle Class
- Wife named Betty – left her love notes
- Son named James Alan
- Dog named Toy
- Woodworking hobby
- Circular white bench around a tree in his yard.
- Chain Smoker
- Bit his fingernails
- Drove a Chevy, watched stock car racing, and drank Miller-Lite
- Suffered from High Blood Pressure and Migraines
Jim Springer

- Calls his 37 year separated twin in February 1980
  - Everything down to the dog’s name is the same (except sons James Allan vs. James Alan)
- When played their voices, they would mistake themselves for their twin
- They are the first in Thomas Bouchard’s twin study
- Studied 80 pairs of identical twins reared apart
Separated Twins

Critics of separated twin studies note that such similarities can be found between strangers.

Let us see if they might be correct.

but

Researchers point out that differences between fraternal twins are greater than identical twins.
<table>
<thead>
<tr>
<th>Attitude Item</th>
<th>MZ Corr.</th>
<th>MZ n</th>
<th>DZ Corr.</th>
<th>DZ n</th>
<th>Heritability, $2(\text{MZ} - \text{DZ})$</th>
<th>Shared Environment, $(2 \times \text{DZ}) - \text{MZ}$</th>
<th>Unshared Environment, $1 - \text{MZ}$</th>
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<td>0.53</td>
<td>3.40</td>
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</tbody>
</table>

Source: Access to the data provided by Eaves et al., principal investigators, Virginia 30K twin study (see note 7).

$^a$ The MZ–DZ correlation difference is statistically significant for all of the table items at the 0.01 level or above.
Adoption Studies

Adoption studies, as opposed to twin studies, suggest that adoptees (who are biologically unrelated) tend to be more different from their adoptive parents and siblings than their biological parents.
Where is the environment?

- Adoptees bear more resemblance in their outgoingness and agreeableness to their biological parents than to their adopted parents.
- Two adopted children in the same home bear no more resemblance to each other than kids from two separate families.
Adoptive Studies

Adoptive studies strongly point to the simple fact that biologically related children turn out to be different in a family. So investigators ask:

Why are children in the same family so different?

Do siblings have VASTLY differing experiences?

Do siblings, despite sharing half of their genes, have different combinations of the other half of their genes?

Ultimate question: Does parenting have an effect?
Parenting

Parenting does have an effect on biologically related and unrelated children.

<table>
<thead>
<tr>
<th>Parenting Influences children’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes, Values</td>
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<tr>
<td>Manners, Beliefs</td>
</tr>
<tr>
<td>Faith, Politics</td>
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</tbody>
</table>

“Mom may be holding a full house while Dad has a straight flush, yet when junior gets a random half of each of their cards his poker hand may be a loser.” David Lykken (2001)
Nature and Nurture

Some human traits are fixed, such as having two eyes. However, most psychological traits are liable to change with environmental experience.

Genes provide choices for the organism to change its form or traits when environmental variables change. Therefore, genes are pliable.
Gene-Environment Interaction

Genes can influence traits which affect responses, and environment can affect gene activity.

A genetic predisposition that makes a child restless and hyperactive evokes an angry response from his parents. A stressful environment can trigger genes to manufacture neurotransmitters leading to depression.
Gene-Environment Interaction

Genes and environment affect our traits individually, but more important are their interactive effects.

People respond differently to Rowan Atkinson (Mr. Bean) than Orlando Bloom.
Molecular genetics is a branch extension of behavior genetics that asks the question, “Do genes influence behavior?”
Molecular geneticists are trying to identify genes that put people at risk for disorders. With this kind of knowledge, parents can decide to abort pregnancies in which the fetus is suspected of having such disorders.

However, this opens up a real concern regarding ethical issues involving such choices.
VI. Evolutionary Perspective
Natural Selection

Natural selection is an evolutionary process through which adaptive traits are passed on to ongoing generations because these traits help animals survive and reproduce.

According to natural selection, those organisms that are best adapted to their environment are most likely to survive and reproduce.

Thus their genes are more likely to get passed along.
Evolutionary Psychology

- Study the origins of behavior and mental processes emphasizing the adaptive or survival value of such traits.
- Behavioral Genetics attempts to explain differences in populations and attribute how much of that is due to genes.
- Evolutionary Psychology attempts to explain common behavior by looking at what was helpful to survival of the species.
Evolutionary Psychology

- Evolutionary psychologists believe that behavior is strongly influenced by inherited factors, and that every human being acts (consciously, but mostly unconsciously) to enhance their **inclusive fitness** –
  - frequency and distribution of their genes in future generations. As Steven Pinker puts it, 'the ultimate goal that the mind was designed to attain is maximizing the number of copies of the genes that created it'.

- **Selfish Gene Theory** – Richard Dawkins
Human Traits

A number of human traits have been identified as a result of pressures afforded by natural selection.

- Why do infants fear strangers when they become mobile?
- Why are most parents so passionately devoted to their children?
- Why do people fear spiders and snakes?
Partner Selection

Females and males have a particular interest in selecting partners that will enhance their reproductive success and inclusive fitness.
Human Sexuality

Gender Differences in Sexuality

Males and females, to a large extent, behave and think similarly. Differences in sexes arise in regards to reproductive behaviors.

- Due to the reproductive reality, it would seem most adaptive for women to find a mate that gives the best genes, resources, and long-term parental care.
- Males can pass on as many genes as they can find willing partners.
What Women Want?

(Singh 1995)

• Healthy looking men
  • Affluent
  • Mature
  • Dominant
  • Bold
• Offer long-term mating and investment
  (Gangestad and Simpson 2000)
Explanation of Partner Selection in Women

- **Females** have evolved mechanisms that enable them to detect men that will transfer resources to their offspring (i.e. health and paternal investment).

- These are sometimes referred to as 'good provider' and 'good genes' attributes in the male.
What Guys Want?

- A waist to hip ratio (WHR) of about 0.7 (the hour glass figure)
- Full lips and small noses
- Youthfulness
- These features are associated with a strong immune system, high estrogen level, and developmental stability
Explanation of Partner Selection in Men

- Males have evolved mechanisms that enable them to detect females that promise rapid production of offspring, and a disinclination to mate with other men (i.e. health, fertility and faithfulness)
Mating Preferences

Males look for youthful appearing females in order to pass their genes into the future. Females, on the other hand, look for maturity, dominance, affluence and boldness in males. Data based on 37 cultures.
Critiquing the Evolutionary Perspective

Evolutionary psychologists take a behavior and work backward to explain it in terms of natural selection.

Evolutionary psychology proposes genetic determinism and undercuts morality in establishing society.

Where genders are unequal, gender preferences are very different, but when they are closely equal, preferences are more similar.
Evolutionary psychologists argue that we need to test behaviors that explain evolutionary principles.

Evolutionary psychologists remind us how we have adapted, but do not dictate how we ought to be.

Males and females are more alike than different, and if we study these differences we can establish their causes.