

Science Reviewer

Science

Science – Systematized / Processed Knowledge (Understanding of the natural world).

The Scientific Method

Steps:

Observation → Question → Research Topic → Form Hypothesis → Conduct Experiment → Analyze Results → Accept Hypothesis / Reject Hypothesis → Report Results

Key Figures:

- **Claudius Ptolemy (87–150)**: Proposed the Geocentric model (Earth is at the center of the universe).
 - **Nicolas Copernicus (1473–1543)**: Proposed the Heliocentric model (Sun is at the center of the universe).
 - **Galileo Galilei (1564–1642)**: Improved the spyglass telescope (originally invented by Hans Lippershey, a Dutch eyeglass maker) and supported the Heliocentric model.
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Role of Science in Society

1. Generating Knowledge and Understanding

- A systematic way of acquiring knowledge about the natural world.
- Helps us understand the universe, leading to new discoveries.
- Informs various aspects of life (medicine, agriculture, etc.).

2. Driving Technological Advancements

- Discoveries often translate into technological advancements (communication, transportation, etc.).
- Enhances efficiency, connectivity, and access to information.

3. Improving Healthcare

- Longer life expectancies and improved quality of life.
- Breakthroughs in medicine.

4. Addressing Societal Challenges

- Climate change, resource scarcity, food security.
- Helps develop sustainable energy sources, improve agricultural practices, and protect biodiversity.
- Informs policies related to environmental protection.

Technology

Technology – Applied science

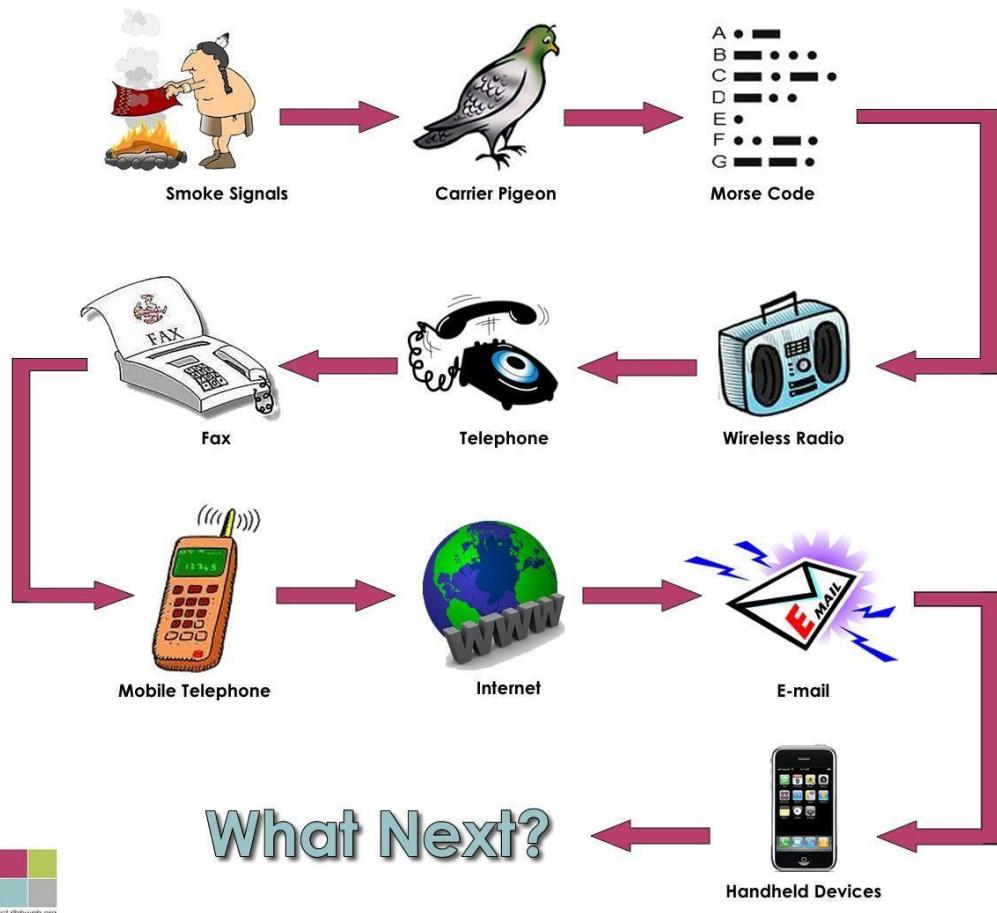
Role of Technology in Society

- 1. Enhancing Communication and Connectivity**
 - Revolutionized enabling instant global connections.
 - Fostered increased collaboration and understanding between individuals.
- 2. Transforming Education and Learning**
 - Provides access to vast amounts of information and resources.
 - Online learning platforms, virtual classrooms, educational apps.
- 3. Improving Healthcare**
 - Led to new treatments, diagnostic tools, and monitoring systems.
- 4. Boosting Productivity and Economic Growth**
 - Automation and artificial intelligence have increased efficiency and productivity in various industries.
 - Led to economic growth, job creation, and improved standards of living for many.

Sustainable Energy Examples

1. Solar Heat Energy
2. Solar Electricity Energy
3. Wind Energy
4. Geothermal Energy
5. Hydropower Energy
6. Ocean Energy

Communication Timeline



What is AI?

1. **Machine Learning** – to recognize patterns based on algorithms.
2. **Neural Networks** – computer systems designed to imitate the neurons in a brain.
3. **Natural Language Processing** - ability to understand speech.
4. **Robotics** – can assist people without actual human involvement.

Advantages & Disadvantages of AI

Advantages of AI	Disadvantages of AI
Reduced Human Mistakes	High Production Costs
Better Human Workflows Were Discovered	Making Humans Lazy
Deploying/Employing AI in High-Risk Circumstances	Rise in Unemployment
24/7 Availability	Lacking the skills to innovate

Science vs. Technology

Science	Technology
Deals with the natural world.	Deals with how humans modify, change, alter, or control the natural world.
Is very concerned with <i>what exists</i> in the natural world. (i.e.: Biology, Chemistry, Physics, Astronomy, Geology, etc.)	Is very concerned with <i>what can or should be designed, made, or developed</i> from natural world materials and substances to satisfy human needs and wants
Is concerned with processes that seek out the meaning of the natural world by <i>“inquiry”, “discovering what is”, “exploring”, and using “the Scientific Method.”</i>	Is concerned with such processes that we use to alter/change the natural world such as <i>“Invention”, “Innovation”, “Practical Problem, and Design.”</i>

What is STS?

- **Interdisciplinary study of interaction of science and technology with society and culture.**
 - The realization that discoveries and inventions are shaped by historical forces and, in turn, influence values, aspirations, events, and institutions, thus shaping the course of history.
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Positive Impacts of STS

1. **Improved Healthcare** – Medical technology advancements have led to earlier disease detection, more effective treatments, and increased life expectancy.
 2. **Increased Connectivity** – The internet and mobile devices have connected people globally, enabling instant communication, access to information, and global networking.
 3. **Enhanced Productivity** – Technology has automated tasks, streamlined processes, and improved efficiency in various industries, boosting productivity and economic growth.
 4. **Greater Convenience** – Smart devices, online services, and digital tools have simplified everyday tasks such as shopping, banking, learning, and transportation, making life more efficient and accessible.
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Negative Impacts of STS

1. **Social Isolation and Reduced Communication** – Excessive screen time and social media use can lead to social isolation, reduced face-to-face interaction, and decreased empathy.
2. **Environmental Damage** – Industrialization and technological advancements have contributed to pollution, resource depletion, and climate change.
3. **Privacy Concerns** – Data breaches, surveillance, and the misuse of personal information raise concerns about privacy and security.
4. **Health Issues** – Prolonged screen time can cause eye strain, sleep disturbances, and other health problems.
5. **Dependence and Addiction** – Over-reliance on technology can lead to addiction, decreased critical thinking skills, and a diminished ability to cope with real-world challenges.
6. **Spread of Misinformation** – The internet and social media can facilitate the rapid spread of fake news and misinformation.

7. **Job Displacement** – Automation and technological advancements can lead to job losses in certain sectors.
 8. **Ethical Concerns** – Emerging technologies like artificial intelligence and biotechnology raise ethical dilemmas regarding their potential impact on society and humanity.
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Development of the Atomic Bomb

- **1939** – Einstein's letter to FDR; Germany invades Poland.
 - **1941** – FDR authorizes atomic bomb project.
 - **1942** – Oppenheimer named to lead Manhattan Project.
 - **1945** – FDR dies; first atomic bomb test; Hiroshima bombed.
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Automation

Automation – The replacement of human workers with machines.

Reasons for Automation

- Shortage of labor
- High cost of labor
- Increased productivity
- Competition
- Safety
- Reducing manufacturing lead time
- Lower costs in the long run

Advantages of Automation

1. Increased productivity
2. Reduced costs
3. Improved accuracy
4. Enhanced safety and greater scalability
5. Frees employees from repetitive tasks, allowing them to focus on more strategic work
6. Consistency and reduced errors, resulting in higher quality output

Disadvantages of Automation

1. **High Initial Costs** – Implementing automation requires significant upfront investment in technology, equipment, and infrastructure.

2. **Job Displacement** – Machines replacing human workers may lead to unemployment, requiring retraining or alternative employment.
 3. **Decreased Human Interaction** – May affect employee morale and teamwork.
 4. **Security Risks** – Automated systems can be vulnerable to cyberattacks or data breaches.
 5. **Reduced Flexibility** – Automated systems are often designed for specific tasks and may not adapt easily to new processes.
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Transhumanism

- A growing social movement that advocates the ethical use of technologies to enhance human capabilities.
- An intellectual and cultural movement that affirms the possibility and desirability of transcending the limitations of the human body through applied reason.
- **Humanism** is a philosophical and intellectual movement that aims to enhance human abilities using technology.

Definition	Examples
<p>Nick Bostrom (2005) defines transhumanism as:</p> <p>“An intellectual and cultural movement supporting the use of science and technology to improve human and physical characteristics and capacities, with the goal of transcending human biological limitations and ultimately achieving a posthuman condition.</p>	<p>Bionic Implants: Bionic implants are artificial devices surgically implanted into the human body to augment or restore biological functions. For example, artificial exoskeletons can help increase strength & endurance while bionic limbs can be used by people who lose limbs in an accident.</p>

Technology and Institutions

Transhumanists are fascinated by the idea of the cyborg: a creature that is **part human and part technological systems**.

How AI relates to Transhumanism

1. **Cognitive Enhancement** – AI is seen as a tool to enhance human intelligence, memory, and other cognitive abilities
2. **Physical Augmentation** – Transhumanists envision AI-powered prosthetics and other technologies that can augment physical capabilities.

History

A chronological record of significant events, often including an explanation of their causes.

Paleolithic Age (500,000 BC – 10,000 BC)

Old Stone Age – a prehistoric period characterized by using stone tools and the dominance of hunting and gathering as a way of life.

Artifacts: stone axes, bone needles, hearth sites

Key Characteristics (Paleolithic):

- **Stone Tools:** The defining feature of the Paleolithic age is the development and use of stone tools, starting with simple pebble tools and progressing to more sophisticated hand axes, blades, and eventually bone tools.
- Our prehistoric ancestors also gained some knowledge in botany by classifying plants as edible or poisonous.
- **Hunter-Gatherer Lifestyle:** Paleolithic humans were nomadic hunter-gatherers, relying on hunting wild animals, fishing, and collecting wild plants for sustenance.
- **Early Forms of Art:** Evidence suggests that Paleolithic humans created cave paintings, rock art, and small sculptures, indicating early forms of artistic expression and symbolic thought.

Impacts on History (Paleolithic):

- Improved diet
- Enhanced security
- Enabled early humans to increase their numbers

Mesolithic Age (10,000 BC – 4,000 BC)

The period between the Paleolithic and the Neolithic, associated with the rise to dominance of microlithics (very small geometric form tools commonly used in composite tools).

Artifacts: leatherwork, basketry, fishing tackle, stone axes, wooden objects, canoes, bows, domesticating animals, stone circles, hinges

Key Characteristics (Mesolithic):

- **Climate Change:** The end of the last glacial period led to warmer temperatures and rising sea levels, impacting human settlements and resource availability.
- **Microliths:** People transitioned from using large, coarsely chipped stone tools to smaller, more refined tools called microliths, which were often used as parts of composite tools like arrowheads and spearheads.
- **Hunter-Gatherer Lifestyle:** While still relying on hunting and gathering, Mesolithic people developed more sophisticated hunting techniques, including group hunting and fishing.
- **Early Forms of Domestication:** Evidence suggests that some Mesolithic communities began experimenting with plant and animal domestication, laying the groundwork for the Neolithic revolution.
- **Settlement Patterns:** Some Mesolithic groups began to form more permanent settlements, particularly in areas with abundant resources.
- **Pottery and Art:** In some regions, Mesolithic people started making pottery and creating rock paintings, often depicting hunting scenes or ritual activities.

Mesolithic Technology:

- **Microliths:** Small stone tools, typical of Mesolithic technology – fishhooks, harpoon tips, and dart tips.
- The technology shifts from focus on herd game hunting to more varied and specialized activities.
- Generally, broad-spectrum economies persisted for about 5,000 years longer in Europe than in the Middle East, and even longer in Meso-America.

Impacts on History (Mesolithic):

- The gradual domestication of plants and animals led to the beginnings of settled communities.

Neolithic Age (4000 BC – 2300 BC)

The Neolithic era, also known as the New Stone Age, is a period in human history characterized by the development of agriculture, the domestication of animals, and the establishment of settled communities.

Artifacts: pottery, polished stone tools, spinning and weaving tools, wooden plows, sickles

Impacts on History (Neolithic):

- Dependable year-round food supply enabled division of labor and specialization that spurred invention and innovation.
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Bronze Age (2300 BC – 700 BC)

The Bronze Age was a historical period characterized by the widespread use of bronze tools and weapons, typically occurring between 3300 BC and 1200 BC in various parts of the world.

Artifacts: bronze jewelry, tools, and weapons

Key Characteristics (Bronze Age):

- **Bronze Metallurgy:** The Bronze Age is defined by the use of bronze, an alloy of copper and tin, which was a superior material for tools and weapons compared to earlier stone tools.
- **Social Development:** This period saw the rise of complex societies, including the development of urban centers, trade networks, and early forms of writing.

Impacts on History (Bronze Age):

- Stone tools were gradually replaced by metal ones, enabling humans to alter their environment at a greater rate.
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Iron Age (700 BC – 450 AD) - Iron was used as the main metal.

Artifacts: iron chisels, ornamental jewelry, swords, axes, and spearheads

Impacts on History (Iron Age):

- Military dominance from the use of iron weapons
 - The use of iron-bladed plows enabled humans to increase food production.
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Mesopotamian Civilization

The Wheel

- The Mesopotamians used the wheel to make pottery wheels. Before this, pottery was made out of wet clay formed by hand then laid out to dry.
 - Goods such as tin and copper that were imported to Mesopotamia could be transported faster.
 - They used the wheel to make war chariots.
 - The wheel was used for getting water for the irrigation system.
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Engineers of Early Civilizations

- Mesopotamian engineers used clay tablets to document irrigation systems, city plans, and more.
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Mesopotamian Astronomy

- Astronomy was a huge part of Mesopotamian culture. Priests were the ones who studied the stars.
 - They made a **12-month calendar** that was based on moon cycles. The priests could predict solstices and eclipses and produce astronomical tables.
 - **The Ziggurat of Ur (2100 BC):** In the 3rd millennium BC, the first astronomer-priests watched the night sky on top of ziggurats and discovered the planets.
 - Mesopotamians built **observatories** starting ~6000 years ago.
 - The **ziggurats had seven levels**, one for each wandering object in the sky: Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn → Thus 7 days to the week.
 - They tracked stars – groups rising before the sun at different times of year implied seasonal beginnings for planting and harvesting (**zodiac**).
 - Divided circles into **360 degrees**, each degree into **60 minutes** and each minute into **60 seconds** – we still use this system today!
 - Left written records in **cuneiform**, so we understand them better.
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Mesopotamian Inventions

- **The Wheel:** Oldest wheel found is in Mesopotamia, first used in pottery and then in chariots.

- **Mathematics:** Base number was 60 (instead of 10), divided the minute into 60 seconds and made the circle 360 degrees.
 - **Astronomy:** Tracked the movement of the stars, planets, and the moon. Created the first calendar based on the cycles of the moon.
 - **Technology:** Potter's wheel, irrigation (Archimedes screw 400 years earlier), use of bronze and then iron to make tools and weapons, and looms to make cloth.
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Egyptian Civilization

Engineers of Early Civilizations

- Egyptian engineers built the pyramids and complex irrigation systems.
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Health and God

- Religious beliefs dominated the ancient Egyptian view of healing.
 - Doctors were often priests who were able to communicate with the gods responsible for the health of different parts of the body.
 - Illness was believed to be due to the presence of evil spirits or poisons, and removing these from the body with prayers to the gods would cure the disease.
 - Medicines were used to relieve pain but were not thought to play any other role in the healing process.
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Egyptian Astronomy

- Egyptians believed that many of the stars and planets were actually the gods and goddesses they worshipped.
- In particular, they were drawn to two bright stars that always could be seen circling the North Pole. The Egyptians referred to those stars as "***the indestructibles***."
- Today we know them as **Kochab** (Little Dipper / Ursa Minor) and **Mizar** (Big Dipper / Ursa Major).
- Egyptians aligned their pyramids and temples toward the north because they believed their pharaohs became stars in the northern sky after they died.
- The precise orientation of the pyramids demonstrates the high degree of technical skill in watching the heavens. At that time, the pole star was **Thuban** (constellation Draco).

- The annual flooding of the Nile was the foundation of Egyptian civilization and agriculture, so predicting this occurrence with accuracy was the driving force behind the development of Egyptian astronomy.
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Egyptian Inventions

- **Metal Making**
 - Around 3000 BC, the Egyptians discovered that by mixing a small amount of tin ore with copper ore, they could make bronze.
 - Bronze was harder and more durable than other metals of that time. This period became known as the **Bronze Age**. Bronze tools, weapons, armor, building materials, and decorative items have been found.
- **Writing**
 - The ancient Egyptians were among the first groups of people to write and keep records.
 - The earliest form of Egyptian writing was **hieroglyphics**, which combined logographic, syllabic, and alphabetic elements, with some 1,000 distinct characters.
- **Papyrus**
 - Egyptians turned the pith of the *Cyperus papyrus* plant into sheets that could be rolled into scrolls.
- **Ink**
 - Egyptians mixed vegetable gum, soot, and bee wax to make black ink.
 - Eventually, they replaced soot with materials like red ochre to create colored inks.
- **The Ox-drawn Plow and the Sickle**
 - First appeared as early as 2500 BC.
 - Made of bronze, which scored the earth into furrows. Workers with hoes broke clumps of soil and sowed seeds.
 - Along the Nile, they grew wheat and various vegetables.
- **Clocks**
 - Egyptians used obelisks as sundials, tracking shadows to determine the longest and shortest days of the year.
- **The Calendar**
 - Based on the yearly reappearance of **Sirius (the Dog Star)** in the eastern sky, coinciding with the flooding of the Nile.
 - Their solar calendar contained **365 days**, divided into **12 months of 30 days each**, plus **5 festival days**.
- **Toothpaste**
 - Recipes included powdered ox hooves, ashes, burnt eggshells, and pumice.
 - Later versions used rock salt, mint, dried iris flower, and grains of pepper.

- **Surgical Instruments**
 - Egyptians invented medical surgery, recording **48 surgical cases** of injuries to the head, neck, shoulders, breast, and chest.
 - Lists included instruments and instructions for suturing wounds with needle and thread.
 - Tools included lint, swabs, bandages, adhesive plaster, surgical stitches, and cauterization methods.
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Ancient Greek Civilization

Key Aspects of Ancient Greek Civilization

- **Democracy:** Athens, in particular, developed a form of democracy where citizens participated in decision-making, laying the groundwork for modern democratic systems.
 - **Philosophy:** Greek philosophers, like Socrates, Plato, and Aristotle, explored fundamental questions about ethics, knowledge, and the nature of reality, influencing Western thought for centuries.
 - **Art and Architecture:** Ancient Greece is renowned for its sculptures, temples (like the Parthenon), and other architectural achievements that continue to inspire.
 - **Sports:** The Olympic Games, first held in 776 BCE, are a legacy of ancient Greece and are still celebrated today.
 - **Literature and Theatre:** Homer's epic poems (*The Iliad* and *The Odyssey*), as well as Greek tragedies and comedies, are cornerstones of Western literature.
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Early Ideas of the Heavens

- **Ancient Greek Astronomy:**
 - Through the use of models and observations, the Greeks were the first to use a careful and systematic manner to explain the workings of the heavens.
 - Limited to naked-eye observations, their idea of using logic and mathematics as tools for investigating the heavens was revolutionary.
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Ancient Greek Astronomers

- **Eudoxus (c. 380 B.C.):** Created the first model of a geocentric universe. He designed his model as a series of cosmic spheres containing the stars, the Sun, and the Moon, all built around the Earth at its center.
 - **Aristotle:** Borrowed the idea of crystalline spheres from Eudoxus. The Sun, the Moon, and each of the planets had a crystalline sphere. The outermost sphere carried all the stars.
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Eratosthenes (~200 B.C.): Calculation of the Earth's Radius

- Eratosthenes heard about a famous well in the Egyptian city of Syene, on the Nile River. At noon one day each year—the summer solstice (between June 20 and June 22)—the Sun's rays shone straight down into the deep well. They illuminated only the water at the bottom, not the sides of the well on other days, proving that the Sun was directly overhead.
 - In Alexandria, Eratosthenes erected a pole and observed that on the solstice it cast a shadow, proving the Sun was not directly overhead but slightly south.
 - Recognizing the curvature of the Earth and knowing the distance between the two cities, he was able to calculate the planet's circumference.
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The Geocentric Model and Epicycles

- The inclusion of **epicycles** in the Geocentric Model solved the problem of retrograde motion of Mars.
 - This became the **standard model of the universe** for centuries.
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Ancient Greece Contributions

- **Inventions:** Democracy, The Olympics, Theater, The Alphabet
 - **Innovations:** Technology, Science, Architecture, Medicine, Mathematics, Philosophy, Literature, Art, Language, History, and Geography
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Roman Civilization

- The Romans made very little contribution to the sciences.
 - They concentrated on expanding the empire.
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Key Characteristics

- This period saw the rise of Roman power through military expansion and the development of sophisticated political institutions, including consuls and a senate.
 - The Roman army was a key factor in Rome's success, known for its discipline and effectiveness in conquering and controlling vast territories.
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Galen

- Galen became chief physician to the gladiators.
 - Gladiators were always poking spears at each other, and Galen learned a lot about wounds.
 - Wounds of the gladiators became “windows” for Galen to study human anatomy.
 - Galen described cranial nerves and heart valves and showed that arteries carry blood, not air.
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