Class notes

1. A research team proceeded toward the apex of a natural geologic protuberance, the purpose of their expedition being the procurement of a sample of fluid hydride of oxygen in a large vessel, the exact size of which was unspecified. One member of the team precipitately descended, sustaining severe fractural damage to the upper cranial portion of his anatomical structure. Subsequently, the second member of the team performed a self-rotational translation oriented in the direction taken by the first member.

2. Complications arose during an investigation of dietary influence: one researcher was unable to assimilate adipose tissue and another was unable to consume tissue consisting chiefly of muscle fiber. By reciprocal arrangement between the two researchers, total consumption of the viands under consideration was achieved, this leaving the original container of the viands devoid of contents.

3. A young male human was situated near the intersection of two supporting structural elements at right angles to each other: said subject was involved in ingesting a saccharine composition prepared in conjunction with the ritual observance of an annual fixed-day religious festival. Insertion into the saccharine composition of the opposable digit of his forelimb was followed by removal of a drupe of genus prune. Subsequently the subject made a declarative statement regarding the high quality of his character as a young male human.

4. A triumvirate of murine rodents totally deviod of ophthalmic acuity were observed in a state of rapid locomotion in pursuit of an agriculturalist's marital adjunct. Said adjunct then performed triple caudectomy utilizing an acutely honed bladed instrument generally used for the subdivision of edible tissue.

5. A female of the species homo sapiens was the possesor of a small immature ruminant of the genus ovis, the outer most covering of which reflected all wavelengths of visible light with a luminosity equal to that mass of naturally occurring microscopically crystalline water. Regardless of the translational pathway chosen by the homo sapien, the probability was 1 that the forementioned ruminent would select the same pathway.

6. A human female, extremely captious and given to opposed behavior, was questioned as to the dynamic state of her cultivated tract of land used for production of various types of flora. The tract components were enumerated as argentous tone-producing agents, a rare species of oceanine growth and pulchritudinous young females situated in a linear orientation.

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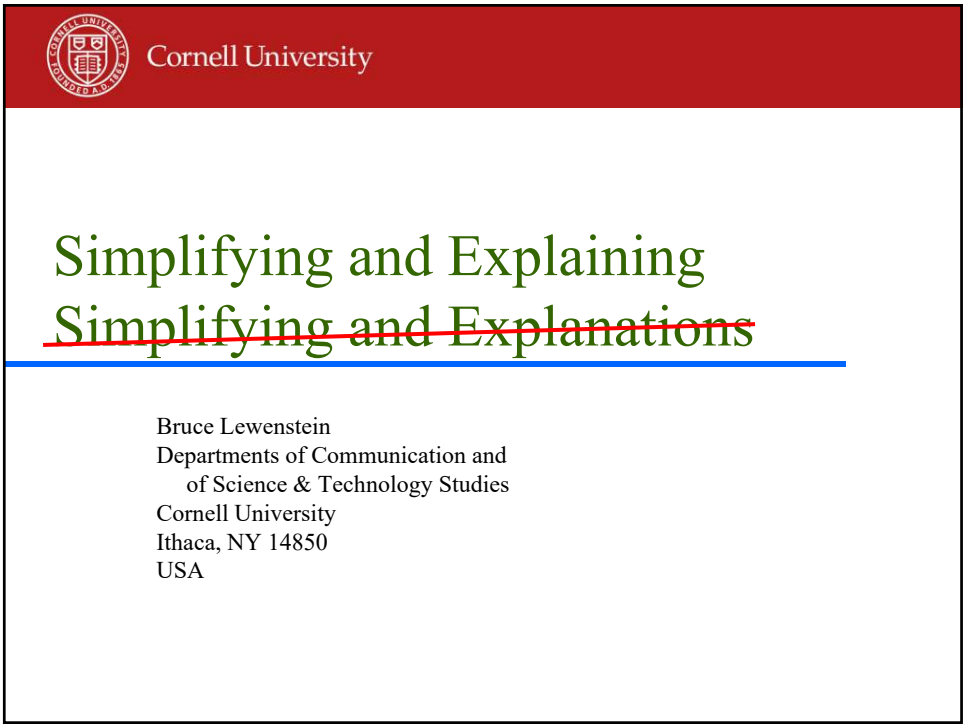

Simplifying

- Shorter words
- Shorter sentences
- Simple grammar
- Visual writing
  - Active words
  - Images, word pictures
  - Show, don't tell
- Explanations


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Why need to explain?

- Lack of information
- Lack of context
- Distinguish between myths and realities

- Problems of story-telling (need one kind of info before another)
- Distinguish between "objectivity" (balance), story-telling exuberance, and scientific consensus/"truth"


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Theory: 3 obstacles to understanding

- Readers don't grasp meaning and use of concept or term
- Readers may struggle to model or mentally represent unfamiliar phenomenon, structure, or process
- Ideas may conflict with pre-existing or tacit models


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Elucidating explanations

- Definitions
- Examples and non-examples


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Elucidating explanation, example

- The term "dietary fiber" refers to the parts of plants that pass through the human stomach and small intestine undigested -- ranging from the brittle husks of whole wheat to the stringy pods of green beans to the gummy flesh of barley grains.


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Quasi-scientific explanations

- Models
- Topic sentences
- Organizing analogies
- Transitions
- Key phrases
- Diagrams


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Quasi-scientific, example

- "If the radio waves are properly tuned, the charged particles can gain energy from the moving waves, just as a surfboard gains energy from a water wave."


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Transformative explanations

- State the implicit or lay theory
- Acknowledge its plausibility
- Demonstrate its inadequacy
- State a better model
- Demonstrate better adequacy


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Transformative explanation
From: Stephan Wilkinson, "Get Out Now!" *Popular Science*, October 2003

"The Challenger accident was eminently survivable," says Gutierrez . . . [followed by explanation of how ejection seats and pods would work on a space shuttle]

NASA's position—especially prior to the release of the final Columbia report, while the agency is mum on safety issues—is that it has preferred to work on improving the overall safety of the shuttle rather than developing an escape system that would involve extensive airframe re-engineering (costing an estimated $1 billion and requiring a lot of downtime).

"[We have] looked at ejection seats, rocket extraction and a variety of separable crew modules," NASA public affairs officer Al Feinberg acknowledged in material sent to Popular Science. "All these concepts have been shown to produce only modest gains in the probability of crew survival while making large impacts on space shuttle payload capability, on-orbit activities and maximum crew size."

Explanation

Theory vs. practice

- Elucidating
- Quasi-scientific
- Transformative
- Define terms
- Compare:
  - Direct comparisons
  - Simile (like/as)
  - Metaphor
  - Analogy
- ??

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Elucidating explanation: Simple information

- Given the dense bamboo thicket that limits visual contact in most panda habitats and the brevity of panda mating season — females ovulate just once a year and can conceive for only a few days — the pandas' ability to perceive the bleat is critical to reproduction among this once-endangered species.
  - https://www.nytimes.com/2018/09/20/science/panda-bleats.html, by Douglas Quenqua, retrieved 22 Sept 2018


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Elucidating explanations: embedded definitions

- Once in its laboratory, the team pulverized the bone fragments and subjected them to a battery of chemical tests. And while it found plenty of amino acids—the building blocks of proteins—the profile of these molecules didn't match collagen.
  - https://www.theatlantic.com/science/archive/2018/09/dinosaur-bone-microbes-debate/570037/, by Ed Yong, retrieved 22 Sept 2018
- Over time, the cells of complex organisms accrue damage in their DNA, which threatens to turn them into tumors. Some cells defuse this threat by entering a state called senescence: They don't die, but they permanently stop growing and dividing. These retired cells accumulate as we get older, and despite their name, they're not idle. They secrete molecules that trigger inflammation, and they've been implicated in some of the health problems of old age.
  - https://www.theatlantic.com/science/archive/2018/09/alzheimers-tau-senolytic-drugs/570667/, by Ed Yong, retrieved 22 Sept 2018


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Elucidating explanation: Simple analogy

- Like a wedge in Pac-Man's mouth, MDMA fits inside a protein that moves serotonin in and out of neurons. The drug eventually causes a flood of serotonin between synapses, increasing its signals.
  - https://www.nytimes.com/2018/09/20/science/octopus-ecstasy-mdma.html, by JoAnna Klein, retrieved 22 Sept 2018
- Creating flu vaccines is an artisanal affair, more like cultivating a crop than making a pharmaceutical.
  - https://www.theatlantic.com/magazine/archive/2018/07/when-the-next-plague-hits/561734/, by Ed Yong, retrieved 22 Sept 2018 *[Note: embedded metaphor – "artisanal affair"]*


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Elucidating explanation: How scale affects results

- [Using the same data, one group claims 55% of ocean is fished; another group says the number is 4%] How could two groups have produced such wildly different answers using the same set of data? At its core, this is a simple academic disagreement about scale…. [One team] quantified that activity by dividing the oceans into a huge grid of around 160,000 squares. Each of these squares had sides that span half a degree of latitude, and an area of around 3,100 square kilometers. And in 2016, around 55 percent of them included some kind of fishing activity…. [Another team] could analyze it at finer resolutions. When they divided the ocean into smaller squares that are 0.1 degrees of latitude wide and take up around 123 square kilometers, they found that fishing activity occurs in just 27 percent of them. And when they used even smaller squares that are 0.01 degrees wide and 1.23 square kilometers in area—the size of a city block—just 4 percent of the ocean is "fished."


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(https://www.theatlantic.com/science/archive/2018/09/wait-so-how-much-of-the-ocean-is-fished-again/569782/, by Ed Yong, retrieved 22 Sept 2018)

Elucidating, 3

- Online 3D map tracks genes at work in mouse brain
- DATELINE: WASHINGTON, Sept 26 2006

A 3D map tracking genes at work in the mouse brain has been completed and posted online, a boon for researchers studying neurological disorders, the institute founded by Microsoft co-founder Paul Allen announced Tuesday.

The Allen Brain Atlas is a World Wide Web-based, three-dimensional map plotting the regions in which 21,000 genes "express" themselves in the brain of the mouse, 90 percent of which are the same as in the human genes.

"This project is an unprecedented union of neuroscience and genomics," said Allen, whose 100 million dollars launched the project in 2003.

"The comprehensive information provided by the atlas will help lead scientists to new insights and propel the field of neuroscience forward dramatically," he said in a statement.

Because humans share more than 90 percent of their genes with mice, researchers can refer to the map to try to understand Alzheimer's and Parkinson's diseases, epilepsy, schizophrenia, autism, addiction and other disorders affecting about 26 percent of US adults, some 58 million persons.

The map pinpoints regions in which certain genes are active, or "expressed," in the brain and links them to brain functions, most of which are the same in mammals.

"This is a multidisciplinary project of unprecedented scale," said Allan Jones, the Institute's scientific officer.

[story continues]
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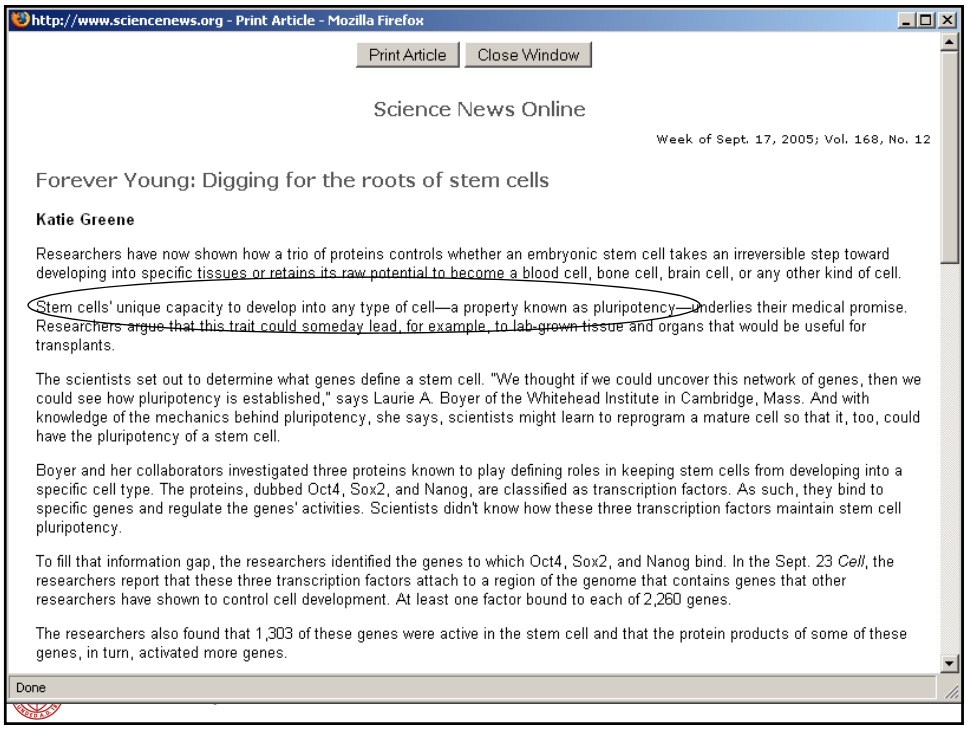

Nevertheless, most of these previous trials involved drugs that were designed to get rid of a different protein that's thought to lie at the heart of Alzheimer's, amyloid-beta. The concept of going after senescent cells is new. "If these cells are found to play important roles in people with neurodegenerative disease, the implications for treatment could be quite significant," says Li-Huei Tsai from MIT, who was not part of the new study.

That's because there are **several "senolytic" drugs** that can eliminate senescent cells, and some of these have already been approved for treating cancers. "If they prove effective in preventing or slowing neurodegeneration, it would represent a truly major advance, especially in light of the continued failures of amyloid-based clinical trials," Tsai says….

His team … worked with a strain of mice that accumulates tau tangles in its neurons by six months of age. By eight months, the mice's neurons have started dying, their brain has started shrinking, and their memories have begun to falter. But [they] found that all of these problems are *preceded* by the buildup of senescent cells, and can be prevented by eliminating those cells at an early stage.

They did this in two ways: first, by genetically engineering the mice's bodies to destroy their own senescent cells when they are fed a particular chemical; and second, by using a **senolytic drug** called "navitoclax" that kills those cells directly. Both approaches were successful at preventing tau tangles.

https://www.theatlantic.com/science/archive/2018/09/alzheimers-tau-senolytic-drugs/570667/, by Ed Yong, retrieved 22 Sept 2018

Metaphor, simile, analogy

(Adapted from: https://www.copyblogger.com/metaphor-simile-and-analogy-whats-the-difference/, retrieved 22 Sept 2018)

- **A metaphor is a figure of speech that uses one thing to mean another and makes a comparison between the two.** *[verb: to be]*
  - "He's become a shell of a man"
- **A simile compares two different things in order to create a new meaning.** *[like/as]*
  - "He's *like* a shell of a man"
- **An analogy … shows how two different things are similar, but it's a bit more complex … an analogy is more of a logical argument.**
  - "His empty head is like the cavity of a shell – it used to hold important stuff, but not anymore."


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Metaphor and analogy

(Adapted from https://www.quora.com/Whats-the-difference-between-analogy-metaphor-and-simile/answer/Laura-Copeland, retrieved 22 Sept 2018)

Metaphor: *[verb: to be]*

- Cancer cells are those which have **forgotten** how to die.
- He donated sperm, and now his cells are **running around** in the wild.
- I'm a **mosaic of cells** from my ancestors.

Analogy:

- Cells are tiny factories, whose job is to take raw materials and produce a useable product (protein). The factory has the necessary plans/code (DNA) for its products; an assembly line (the endoplasmic reticulum); a warehouse for storing the product (the Golgi apparatus); a main office (the nucleus) that's walled off from the rest of the factory (with a nuclear membrane); etc.


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ANALOGIES AND METAPHORS

"Forming thin films is akin to collecting shower steam on a hand mirror. The process starts with six pieces of glassy sapphire the size of a penny, but thinner. These are mounted to the lid of a four-foot-tall vacuum chamber. At the bottom, three copper crucibles contain chunks of yttrium, barium, and copper.

"Electron beams are shined on the three metallic elements to melt them. They glow orange, blue, and yellow as vapor rises, mixes with seeped-in oxygen and coats the penny-sized pieces with a film the thickness of a soap bubble."


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More analogies

"You would think that the task of capturing the rapidly moving antiprotons from the cloud of debris emanating from the tungsten target would be as impossible as trying to catch the queen bee in the swarm of bees emanating from a kicked-over hive.


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Quasi-scientific explanation: Analogy

- Scientists at the National Oceanic and Atmospheric Administration's Marine Debris Program agree, prevention is the solution. Once it's out there in the open water, it's too hard to clean up.

  "If you think about an overflowing sink, it is obvious that the first step before cleaning up the water is to turn the faucet off. That is exactly how prevention works. By acting to prevent marine debris, we can stop this problem from growing," a representative from the Marine Debris Program said via email.
  - https://www.yahoo.com/news/world-apos-biggest-garbage-patch-090000414.html, by Rayne Ellis (via Mashable), retrieved 22 Sept 2018


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Quasi-scientific explanation: Metaphor

- I walk through a market, gazing at delectable displays of peppers, eggplants, avocados, and goat meat…. As I look around the market, I picture it as an ecological magnet, drawing in all the varied animals that dwell within the forest—and all the viruses that dwell within them.
  - https://www.theatlantic.com/magazine/archive/2018/07/when-the-next-plague-hits/561734/, by Ed Yong, retrieved 22 Sept 2018


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Quasi-scientific: Present a model

- Like analogies, present a model
- "Dr. Salcman compares an aneurysm to a bump on a tire. The weakened wall of the artery balloons outward under the relentless pressure of the heartbeat and, eventually, it bursts. That's death."


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Quasi-scientific/comparison

"Magnify your view of this letter -- X -- one million times, and you can see the molecules the ink is made of. This is the realm of chemistry. Magnify a billion times more, and you can see the atoms the molecules are made of -- the realm of physics. Select one atom, magnify it 10,000 times, and you are inside the nucleus -- the realm of nuclear physics. (By now we can no longer see; light waves have become as large as Pacific groundswells viewed from a rowboat.) Smash the nucleus and its particles disintegrate in a bomb burst of still smaller particles. This is the world of the particle physicist."


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Quasi-scientific, ex. 3

- How does the body regulate cholesterol? The body uses a system like a sink with 2 spigots. One spigot lets in the cholesterol that you eat, the other spigot lets in the cholesterol that your body makes (in the liver). In some people, the sink drains easily (the liver turns cholesterol into bile or acid). But in other people, the sink drain isn't very efficient -- it's too small, or too clogged up, or has the wrong kind of filter on it. Then cholesterol builds up in the sink.


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Transformative explanation

- Acknowledge current explanation
- Demonstrate inadequacy
- Provide a better explanation

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Transformative explanation: Bacterial contamination of household water

Opening:
How do you know your water is safe to drink? Appearances can be deceiving.

State the lay theory:
Given the choice, most people would rather drink a glass of crystal clear ice water instead of a cup of room temperature murky water.

Acknowledge lay theory's apparent merit:
That certainly makes sense. The bottled water industry would probably never have gotten of the ground if its product did not look clean, clear, and refreshing.

Create dissatisfaction with the lay theory:
Looks can be deceiving. Take those same two glasses of water. What if the murky one was really tea and the clear one was a colorless odorless chemical that was deadly if ingested? Things are not always as they seem.

Show how a more orthodox notion better explains the phenomenon:
To test water for bacterial contamination….[give details]

Transformative: Can the US have an Ebola crisis?

In a nearby room, dried blood dots the floor around an old operating table, where a sick lab technician once passed Ebola to five other medical staff members, starting a chain of transmission that eventually enveloped Mikolo and many of his friends. The phlebotomist who drew the blood samples that were used to confirm Ebola also still works at the hospital. I watch as he handles a rack of samples with his bare hands. "Ask someone here, 'Where are the kits that protect you from Ebola?,' " Donat Kuma-Kuma Kenge, the hospital's chief coordinator, tells me. "There aren't any. I know *exactly* what I'm meant to do, but there are no materials—here, in the place where there was Ebola…."

Common sense

The hospital's challenges are considerable, but as I walk around, I realize that they are familiar. Even though the United States is 500 times as wealthy as the Congo, the laments I heard from people in both countries were uncannily similar—different in degree, but not in kind. Protective equipment is scarce in the Congo, but even America's stockpiles would quickly be depleted in a serious epidemic. Unfamiliarity with Ebola allowed the virus to spread among the staff of Kikwit's hospital, just as it did among nurses in Dallas, where an infected patient landed in September 2014. In Kikwit, a lack of running water makes hygiene a luxury, but even in the U.S., getting medical professionals to wash their hands or follow other best practices is surprisingly hard; every year, at least 70,000 Americans die after picking up infections in hospitals. And most of all, the people in both countries worry that brief spates of foresight and preparedness will always give way to negligence and entropy.

Alternate explanation

In the U.S., attention and money have crested and then crashed with each new crisis: anthrax in 2001, SARS in 2003. Resources, hurriedly assembled, dwindle. Research into countermeasures fizzles. "We fund this thing like Minnesota snow," Michael Osterholm says. "There's a lot in January, but in July it's all melted."

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https://www.theatlantic.com/magazine/archive/2018/07/when-the-next-plague-hits/561734/, by Ed Yong, retrieved 22 Sept 2018

Transformative explanation
From: Carl Hoffman, "The Shape of Wings to Come," *Popular Science*, October 2003

It seems ludicrous to think of an F-16 fighter jet as crude. But spend a few hours at the beach watching the lowly, scavenging seagull as it swoops over the sand, eyes a leftover french fry, pauses a moment, drops earthward, lands, grabs the morsel, and takes wing again. Not an aircraft in the world can match that performance. "And the seagull doesn't even use its tail during steady flight!" says Barry Lazos, a fluid aerodynamicist at NASA's Langley Research Center in Hampton, Virginia. "When a seagull takes off, lands, or makes sharp turns, it makes dramatic movements with its wings, but during steady flight it endturns with subtle wing changes mostly at the wing tips. It doesn't even have a rudder," he says, shaking his head in amazement. "How does it change its direction? We don't know. In all my study I've found nothing that tells me how birds maneuver without their tails."

ize" ordinary cells of the human body, and how to isolate a naturally immortal class of cells known as human embryonic stem cells.

Immortal, in biologists' parlance, refers to the ability of cells grown in glassware to grow and divide indefinitely without becoming cancerous — an ability in marked contrast to that of normal body cells, which can divide only 50 or so times before hitting senescence.

Immortality of the cell is not the same as immortality of the entire organism, but the two are not necessarily unrelated. The very existence of a perpetually enduring cell is proof that biological systems don't have to rust and decay as man-made machines do. They can renew themselves indefinitely, suggesting that there is no biological limit on longevity. The bristlecone pine, for example, lives 5,000 years.

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Some of everything

After the first millisecond the universe was a featureless fireball about 30 million times hotter than the surface of the sun, 50 billion times denser than lead, and, by the age of one second, it had expanded and thinned to 20 light-years. At that time, presumably, the grainy subatomic ingredients of every leaf, worm, star, rock, manhole cover, automobile, cat, dinosaur, running shoe, and every one of us—all entities past and potential—were combined in white-hot, soupy intimacy with all of space. These initial conditions set immutable limits on the density of all matter and determined the course of cosmic evolution.

The big bang expansion is not an explosion in the classic sense, in which objects are flying out through preexisting space like shrapnel. Space itself is expanding, stretching outward where it had not previously extended, sometimes at velocities faster than the speed of light—a limit that applies to light and other signals but not to space.

The rate at which the universe and all its objects are moving apart—called the Hubble constant—is one of the most important numbers in science. It is expressed in kilometers per second per million light-years (velocity divided by distance). Understanding that number, cosmologists suggest, is key to understanding the natural order of things. The number depends on the amount of "stuff" in the universe, its character, and the degree to which its gravitational forces are retarding the expansion. Those factors in turn affect other events. By tracking the expansion backward, like rewinding a videotape, scientists have sought to define the age, shape, and scale of the universe.

Vivid detail, w/defn

Transf.

Embedded defn

Short sentences

Metaph.