Name: _____ Date: _____

Nectar, Minus the Water

Reading level 14 · 1391 words

Honey is mostly an act of subtraction. Flower nectar is usually 70 to 80 percent water. Finished honey holds only about 15.5 to 18 percent. Everything in between is work. A forager drinks nectar through her proboscis into her honey stomach, or crop, a pouch that holds about 40 milligrams of liquid; one estimate puts a large load for some strains at around 70 milligrams. A little rough arithmetic shows the scale. If nectar is three-quarters water and honey is about one-sixth water, the sugar must be made more than three times as strong, so a single kilogram of honey begins as more than three kilograms of nectar, carried home in drops weighing a few hundredths of a gram each.

The chemistry starts before the bee is home. As a forager swallows nectar, she adds invertase, an enzyme that begins splitting sucrose, the flower's main sugar, into simpler sugars. Other enzymes and proteins from her hypopharyngeal gland are mixed in as well. In the hive she passes the load to younger food-handling bees, which spread it into wax cells and add a second enzyme, glucose oxidase. That enzyme converts some of the glucose into gluconic acid and hydrogen peroxide. The bees then fan their wings to drive water off into the warm air of the nest, and they cap each finished cell with wax. By then the sugars are mostly two simple ones, fructose and glucose.

Each of those steps helps honey last. It is so sugary and so acidic that many germs cannot grow in it, and the hydrogen peroxide made by glucose oxidase further suppresses bacteria. Stored properly, honey does not spoil, and honey dug up by archaeologists has proven edible after thousands of years. One popular version of the story deserves more caution. It is often said that honey fit to eat was found in ancient Egyptian tombs, but at least one careful summary of the evidence reports that none has been found there, and that the cases people cite were other substances or only chemical traces. The general claim rests on other finds; that particular example is weaker than its fame suggests.

The labor is divided by age. For roughly the first ten days of her adult life, a worker cleans the hive and feeds the larvae. Only after about the twentieth day does she leave to forage, and a worker born in spring or summer lives only a few weeks. A forager may visit anywhere from about 100 to 1,000 flowers on a single trip and makes around ten trips a day. Building storage is expensive, too: honey bees eat about 8.4 pounds of honey to secrete one pound of wax. The six-sided cell is often explained as the shape that uses the least material for a given volume, though the biologist D'Arcy Wentworth Thompson argued that it may simply emerge, as soap bubbles do, from cells pressed together.

A forager that finds good flowers can recruit her sisters. In the waggle dance, she makes short

straight runs across the upright comb, waggling her body, again and again. The angle of that run relative to straight up matches the angle between the food and the sun, and the longer the waggle phase, the farther away the food lies. The Austrian scientist and Nobel laureate Karl von Frisch was among the first to decode it. The puzzle is far older. Aristotle noticed that a bee returning to the hive is followed by three or four companions, and he admitted that what they gather is hard to see, and that how they do it had not been observed.

Von Frisch's interpretation was not universally accepted. Some scientists argued that the new bees did not read the dance's abstract code at all, and instead found the food by tracking the smell they had picked up from the dancer. The argument began with a time lag: the new bees took far longer to reach the food than the dance seemed to predict. The dispute lasted because no one could follow a single bee through the air. In 2005, researchers from Rothamsted Research in England and the Free University of Berlin attached tiny radar transponders to the new bees and tracked them with harmonic radar. Most of them headed straight for the area around the food, just as von Frisch's reading of the dance said they would, and then hunted about nearby; that local search accounted for the lag.

The most convincing trial was a trick. Some new bees were caught as they left the hive and released at another spot some distance away. They did not fly to the food. They flew in the direction that would have taken them to it from the hive, which shows they were carrying the dance's instructions rather than following a scent trail. Odor still matters; bees that follow a dance can use smells from the dancer, and they do not always translate the code correctly. The code is not perfect, either: dances on a flat, level surface contain more errors than dances on an upright comb. The fair conclusion is that both camps were partly right. The dance carries a map, and smell helps finish the search.

All of this explains honey. It does not explain why bees matter so much to people. Pollination is the transfer of pollen from a flower's male anther to a female stigma, and in plants that cannot fertilize themselves, seeds form only when the pollen comes from a plant of the same species. Bees carry it on branched, plume-like hairs that set them apart from their close relatives the wasps, and they find flowers partly by ultraviolet patterns on petals that we cannot see. The United States Department of Agriculture estimates that crops that need bees are worth more than 20 billion dollars a year in the United States, and that honey bees help pollinate more than a third of the country's fruit and vegetables. An older estimate credited honey bees with 14.6 billion dollars of crops; such figures depend on what is counted.

The honey bee is also misleading as a symbol. It is one species among more than 20,000 known bees, and it is not native to the Americas: it probably originated in Africa or Asia, and colonies were shipped from England to Virginia as early as 1622. Most bees are solitary. One encyclopedia puts the share above nine in ten species. A Xerces Society bee expert, speaking of North America's bees, gave a figure nearer three in four, and the counting is still going on. Roughly two-thirds of solitary bees nest in soil, in burrows that run straight down.

They make no honey and no wax. The smallest have workers under 2 millimeters long; the largest females reach 39 millimeters.

Some of those wild bees do work a honey bee cannot. In buzz pollination, a bee grips a flower and vibrates its flight muscles, shaking loose pollen that is released only at the right vibration. About one flower in eleven worldwide is pollinated mainly this way, including tomatoes and some blueberries and cranberries. Honey bees cannot do it. Bumblebees can, and greenhouse tomato growers have found bumblebee colonies, up to 50 of them per hectare during the growing season, cheaper in labor and gentler on the plants than shaking the flowers with electric vibrators. When people talk about saving the bees, it is worth remembering that some of the most specialized work is done by bees that never see a hive.

The managed hives are in trouble anyway. Varroa mites severely depleted North American and European honey bee populations in the early 1990s, and colony collapse disorder struck U.S. beekeepers in 2006 and 2007. In June 2025, Department of Agriculture scientists reported high levels of deformed wing virus and acute bee paralysis virus in bees from collapsed colonies in California and other western states, both spread by Varroa mites, and resistance to amitraz, a common treatment, in virtually all the mites they collected. They called the viruses a likely end-stage cause of death, sent their findings to a journal for review, and added that the result does not rule out other long-known stresses. A national survey for April 2025 to April 2026 put annual losses at 39.9 percent, down from 55.6 percent the year before. How the causes combine is still an open question.

Questions

1. Why does the book call honey "an act of subtraction"?

A. Bees remove most of the water from nectar
B. Bees take honey from other hives
C. Honey loses its sugar over time

2. What does glucose oxidase produce that helps honey keep?

A. Wax
B. Hydrogen peroxide and gluconic acid
C. Pollen

3. What did the displaced recruits in the 2005 radar study show?

A. Bees follow only smell
B. Bees cannot fly far
C. The recruits carried the dance's directions, not just a scent trail

4. In this book, what does "solitary" mean?

A. Living alone, not in a colony
B. Making honey

C. Flying only at night

5. Why does the book say the honey bee is a misleading symbol?

A. It does not make honey

B. It is one of more than 20,000 bee species and not native to the Americas

C. It cannot sting

6. What did Department of Agriculture scientists report in June 2025?

A. Colonies were dying only from cold

B. Varroa mites had disappeared

C. High levels of mite-spread viruses, and mites resistant to amitraz

Words to know

proboscis: feeding tube
invertase: sugar-splitting enzyme
transponders: signal tags
solitary: living alone
pollination: pollen transfer
resistance: surviving a poison

Answer key: Nectar, Minus the Water

1. A. Bees remove most of the water from nectar
2. B. Hydrogen peroxide and gluconic acid
3. C. The recruits carried the dance's directions, not just a scent trail
4. A. Living alone, not in a colony
5. B. It is one of more than 20,000 bee species and not native to the Americas
6. C. High levels of mite-spread viruses, and mites resistant to amitraz