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First-Year and Common Reading Guide

An Immense World

How Animals Reveal the Hidden Realms Around Us

By Ed Yong

Guide written by Je Banach

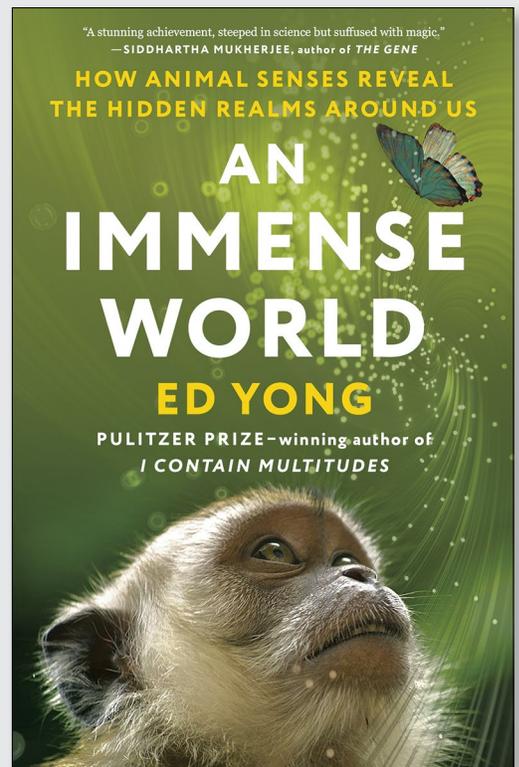
Random House

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ABOUT THE BOOK

With his latest bestselling book, *An Immense World: How Animals Reveal the Hidden Realms Around Us*, Pulitzer Prize-winning science journalist Ed Yong blasts open everything we thought we knew about the animal kingdom and the sensory world. Writing with humor, joy, and a dose of delight in discovery, he tells stunning stories of animals who inhabit the natural world around us and, in so doing, invites us to explore an amazing landscape of sights and sounds, textures and vibrations, smells and tastes, and electric and magnetic fields—many of which escape our human senses. Each animal, Yong explains, lives in its own distinct sensory “bubble” that causes it to experience the world in a unique way. There are beetles attracted to fires, fish that sense electrical currents, snakes that smell with their tongues and crocodiles that feel with the scales on their faces, scallops that see with a multitude of eyes, elephants that “listen” with their feet, and insects that vibrate with beautiful “songs” at frequencies we cannot hear.

While our first instinct may be to consider what these discoveries tell us about our own sensory experiences as humans or about possible future technologies, Yong makes it clear that the purpose of the book lies elsewhere. *An Immense World* is an ode to biodiversity and “animals as animals,” inherently worthy of our care, wonder, and attention. Calling to mind the phrase “more than meets the eye,” Yong’s book reveals a world that is richer, more complex, and much more amazing than anything we may have imagined before we encountered his work—a world imminently worth



ABOUT THE BOOK (CONTINUED)

defending and preserving. At the book's conclusion, Yong warns us about the dire consequences of our disconnection from nature and reminds us of our responsibility to the natural world and the animals that inhabit it with us. He asks us to consider the alarming increase in light and sound pollution generated by humans, which threatens to drastically diminish biodiversity and extinguish the lives of the animals around us. In addition, he calls for action to remedy this.

The guide that follows is meant to provoke dialogue and open up conversation, generate questions, and fuel curiosity. It provides a roadmap to help students engage meaningfully with *An Immense World* and apply what they learn to both their own lives and the broader world we all share.

ABOUT THE AUTHOR

Ed Yong is a Pulitzer Prize-winning science writer on the staff of *The Atlantic*, where he also won the George Polk Award for science reporting, among other honors. His first book, *I Contain Multitudes*, was a *New York Times* bestseller and won numerous awards. His work has appeared in *The New Yorker*, *National Geographic*, *Wired*, *The New York Times*, *Scientific American*, and more. He lives in Washington, D.C., with his wife, Liz Neeley, and their corgi, Typo.

DISCUSSION QUESTIONS

1. What word defined and popularized by the Baltic German zoologist Jakob von Uexküll describes the unique sensory bubble or perceptual world of each animal? Why did Uexküll compare an animal's body to a house and what made his way of looking at animals this way a "unifying and leveling force" (p. 6)? While the sensory bubble Uexküll describes does constrain an animal's life, what does Yong tell us that it alternatively defines? As we explore these "bubbles" and the distinct perceptual experiences of animals, what does the author say will be our biggest liabilities and our greatest assets? What kinds of questions does Yong say we should stop asking about animals' senses? Which questions should we start asking instead?
2. According to philosopher Fiona Macpherson, what reasons do we have to doubt Aristotle's assertion that there are five senses? How does Yong address this in his book? How do many scientists typically study animals' senses, according to Yong, and how does his own approach differ?
3. How do restrictions in our own senses and human biases get in the way of our understanding of animals and their perception? In particular, what sense does Yong say many of us are biased in favor of, even if we are not able to utilize that sense, and how has it influenced our language and impacted our way of talking about our perception of the world around us?
4. How does olfaction differ between dogs and humans, and what is that crucial difference? What does Yong mean when he says that Finn the dog "is not merely assessing the present" when he sniffs but "also reading the past and divining the future" (p. 21)? What do groups like the Jahai people, the Semaq Beri, and the Maniq tell us about the myths surrounding the comparison of human and animal olfaction? What are "smellscapes," and what are some animals that use olfaction for navigation?
5. Which is the simpler sense: taste or smell? What does physiologist John Caprio say is the clear difference between them? What amazing feature allows some animals to make expanded use of the sense of taste?

DISCUSSION QUESTIONS
(CONTINUED)

6. What does Yong mean when he says, “In a way, we see by smelling light” (p. 52)? According to the author, what is the most wondrous thing about light from a biological perspective? What universal feature do the eyes of all animals and humans share and what paradox does Yong say this commonality creates? When it comes to eyes, what was Darwin wrong about and how can his mistake help us to better understand and appreciate the diversity of visual perception?
7. What is the basis of almost all color vision and why does Yong say that color is “fundamentally subjective” (p. 86)? What is a monochromat? What counterintuitive thing about color vision does the existence of so many monochromats hint at? What misunderstanding does Yong overturn about comparisons between monochromats, dichromats, and trichromats? When it comes to UV light, what makes humans “the weirdos” (p. 93)? What does the author mean when he says, “Beauty is not only in the eye of the beholder. It arises because of that eye” (p. 225)?
8. What is nociception and what distinguishes it from pain? What role does this distinction play in the question of whether or not all animals feel pain? What is the trouble with the argument that a lack of a neocortex in fish can be equated with a lack of pain? Why do many scientists believe we should invoke the “precautionary principle” (p. 132)? Instead of focusing on the question of whether pain exists in animals, what question does physiologist Catherine Williams suggest that we ask?
9. What is the most thoroughly studied of the temperature sensors used by animals and humans and how does it work? What allows ground squirrels to hibernate in temperatures humans would find intolerable, and how should this inform our understanding of animals’ heat or cold tolerance? What are some examples of “extremophiles,” and what do we commonly misunderstand about their tolerance for extreme temperatures?
10. What “delicate sense” allows a sea otter to survive as “a small, warm mammal in a big, cold ocean” (p. 157)? What “transforms [this sense] from a coarse sense to an exquisite one” (p. 161)? Although this sense depends upon direct contact for humans and sea otters, how can it “operate at a distance” for many other animals (p. 159)? How do alligators, for instance, accomplish this in order to find food without having seen it? Why do you think, as Yong says, this sense inspires less art and fewer scientific devotees than other senses?
11. How do vibrations allow red-eyed tree frog embryos to escape their predators? Discuss the ways in which other animals utilize surface vibrations and “seismic senses” (p. 202). What are some of the advantages of using surface vibrations over airborne vibrations? What does Yong say is “[p]erhaps the largest distinction between surface vibrations and sounds” and what can it teach us about “the danger of giving in to our preconceptions” (p. 192)?
12. Which of the senses does Yong say sound is most closely related to and why? Despite their similarities, what distinguishes these two senses? What makes hearing a particularly natural primary sense for owls? How do the ears of insects vary from the ears of humans and other animals, and what three lessons about animal hearing does it teach us? How do the mating sounds of the túngara frog demonstrate how the senses “influence the form that beauty takes in the natural world” (p. 223)?
13. What is echolocation and how do bats use it to “see”? In addition to avoiding collisions, what else do bats use it for? How does it differ from the other senses

DISCUSSION QUESTIONS (CONTINUED)

- discussed so far? What are some of the at least 10 challenges of echolocation that Yong explains and how does the bat resolve them? What other animals employ this sense? Why does Yong say that echolocation is “inherently exploratory” (p. 264) and what makes it one of the most accessible of all the senses according to the author?
14. What animals inspired the design of first synthetic battery and the discovery that muscles and nerves run on minute currents? How do weakly electric fish like elephantfish and knifefish use electric fields? How is active electrolocation similar to echolocation? Alternatively, what sets it apart from the other senses? Discuss what Yong means when he writes that “[a]nimal bodies . . . are living batteries” (p. 291). What three important things does the “cabal of electroreceptive critters” (p. 294) tell us? Finally, what does “the convoluted history of the electric sense” also reveal about the language of the brain?
 15. Why does the use of magnetic fields remain the animal sense we know the least about? Unlike the other senses, which are used for communication, what is this sense primarily used for? How do Australian moths use magnetoreception to migrate, even though they fly at night? How do two properties of the magnetic field guide sea turtles in their own migration? What three ideas have been proposed to explain how magnetoreceptors might work?
 16. To truly understand animals’ *Umwelten* and bring our voyage through the senses to a close, what does Yong say we must we consider? What are some of the internal senses and why are they seldom discussed? Why are these internal senses “non-negotiable” (p. 325)? What “difficult problem” (p. 328) must each nervous system solve, and why is this sorting process a “foundational condition of animal existence” (p. 328)?
 17. Why does Yong believe that “our stories and myths are so full of characters who can transfer their consciousness into the bodies of animals” (p. 333)? What is misleading about these forms of representation? What does Yong mean when he says that “[t]he act of sensing creates an illusion that, ironically, makes it harder to appreciate how the senses work” (p. 333)?
 18. What “ecological sin” does Yong say “should be especially easy to appreciate and yet is often ignored” (p. 336)? What does he mean when he says that this is a problem of disconnection? What lesson did we learn during the first year of COVID-19 about our ability to manage this problem? Why isn’t it acceptable to expect animals to simply adapt to extreme levels of pollution? How could redefining wilderness help us to solve the problem of our threatened sensescapes?
 19. At the book’s conclusion, what does Yong say is our greatest sensory skill? Why should we exercise it?

CLASSROOM ACTIVITIES

1. Ask students to write an essay about how *An Immense World* changed their view of animals and the natural and sensory world. Ask them to consider preconceptions they had about animals and the natural world before they read Yong’s book. Then have them explain what most surprised them. What did they learn? How do they think their experience with the book might change or influence their engagement with animals and the natural world going forward?
2. Have a respectful and well-informed debate about the use of animals for research. Split the class into two groups and have one group make the case for

CLASSROOM ACTIVITIES (CONTINUED)

the use of animals in research and the other make a case against the use of animals for research. Then bring the class back together to revisit Chapter 4, which deals with pain, and discuss how Yong addresses this topic.

3. Use class time to brainstorm and research concrete ways to help with conservation issues (e.g. preserving animal habitats, reducing pollution, etc.). Divide the class into three groups. Have one group brainstorm and do research about how to make positive changes on an individual basis. Have the second group consider and research what could be done at a local or state level. Have the third group come up with ideas for what might be accomplished at the federal level. Invite each group to present their ideas to the class; each group should support their arguments with concrete examples. Bring the class together to discuss which actions might be viable and how you might work towards these goals as individuals and together as a class.
4. Throughout his book, Yong speaks about the restricting influence of human biases on perception. He speaks of our predilection for visual language, even though many people cannot see, and notes that scientists with backgrounds in the arts or forms of perceptual divergence like synesthesia or the ability to echolocate, for example, have helped them to “step outside their *Umwelten* and embrace those of other creatures.” Have students discuss biases that affect their own perception and our environment. How do they suggest that they might address this? The discussion should cover what biases we have and how we might move past them to expand our empathy toward both other animals and other humans.

RESEARCH OPPORTUNITIES

After researching the topics below, students might use what they have learned to:

- Write a research paper
- Deliver a presentation or TED Talk
- Record an educational podcast or video
- Create a website, social media account, or newsletter
- Initiate a service project

1. Service Dogs

In Chapter 1, the author explains how our cultural reliance on the visual can lead to us overlooking and even suppressing dogs’ primary *Umwelten*: their sense of smell. Rather than conducting research to try to establish just how sensitive a dog’s nose is compared to a human nose, he suggests that “it’s more instructive to look at what dogs can actually do” (p. 19). Invite your students to learn more about dogs—specifically, service dogs. They can begin by starting with information provided by the American Kennel Club (tinyurl.com/ServiceDogs101) and reviewing language in the Americans with Disabilities Act (tinyurl.com/ServiceAnimalsADA). Next, they should research service dog organizations. A simple Google search can reveal local service dog organizations in your area. Students should adopt Yong’s approach and ask questions such as: What do these dogs actually do? How do we “redirect their *Umwelten* in service of our needs to compensate for our olfactory shortcomings” (p. 20)? In order to answer these questions, students should investigate how a dog qualifies to be a service dog, what senses a dog uses in its service, and the ways in which service dogs assist humans. How do the answers to these questions help us to better understand and appreciate the *Umwelten* of our canine friends? How should this inform and affect our interactions with them?

RESEARCH OPPORTUNITIES (CONTINUED)

2. Noise Pollution and the Clean Air Act

In Chapter 13, Yong introduces readers to what he calls “threatened sensescapes” (p. 335). “Noise can degrade habitats that look otherwise idyllic, and make otherwise livable places unlivable” (p. 345), he writes. Review the section on noise pollution in this chapter and then have students conduct a deeper dive into this topic with the goal of answering questions such as: How is noise pollution affecting the animal kingdom and the natural world? What are the sources of this? Why is it so important that we “[s]ave the [q]uiet” (p. 335)? And how might this be accomplished? They might research the Clean Air Act using resources such as the EPA’s overview of the act (tinyurl.com/NoisePollutionEPA) and articles from *The New Yorker* (tinyurl.com/NoisePollutionTNY) or the BBC (tinyurl.com/NoisePollutionBBC). How has noise pollution changed since the Clean Air Act was enacted? What other actions or legislation have helped us to reduce sound pollution? How might these examples help us create a roadmap for continuing to make progress in this area?

3. Local and Federal Conservation Organizations

At the conclusion of the book, Yong explains that when it comes to animals’ ability to cope with the changes being brought upon the natural world by humans at an unprecedented pace, “adaptation is not always possible” (p. 347) and survival is subsequently threatened. “A better understanding of the senses can show us how we’re defiling the natural world. It can also point us to ways of saving it” (p. 349), he writes. Explore the ways in which conservation organizations are working towards this goal. Present students with a list of local and/or federal conservation organizations and ask them to choose an organization to research. They should learn about the organization’s history and mission. What projects is the organization currently supporting? What does the organization hope to do? What challenges and obstacles has it faced? Most importantly, what impact has it had and how has this been accomplished? How does its recognition and understanding of the Umwelten of the animals it seeks to protect actually help to ensure its success, as Yong suggests?

SERVICE LEARNING PROJECTS

These projects are designed to connect students’ learning experiences with the larger community

1. Local Lights Out

Review the section of the final chapter of Yong’s book that deals with light pollution. Next, explore Audubon’s Lights Out program together and make a plan to participate. Information about the program can be found at www.audubon.org/lights-out-program. Specific information about how to bring Lights Out to a city or town near you is available at www.audubon.org/news/how-bring-lights-out-city-near-you. You can also find out if there is a local chapter in your area that already exists by visiting www.audubon.org/conservation/existing-lights-out-programs. Finally, research local organizations that could make a difference by turning their lights out. Then plan with students to write letters to those organizations and ask if they would participate in the Lights Out program. You might also create a Lights Out plan for your own school community.

2. Take Action: Become a Conservation Organization Volunteer or Ambassador

Research local and federal conservation organizations (one such list can be found here: www.conservation-careers.com/top-us-conservation-organizations) and their volunteer opportunities. Choose one or two organizations to join as a class and research ways to get involved. These organizations usually have lists on their website

SERVICE LEARNING PROJECTS (CONTINUED)

with numerous ways to become involved via the organization, as well as at home or in the classroom. Find the one that works best for you. You might share updates about your involvement via school news communication channels.

3. Start an *Immense World* Club at Your School

Meet weekly or monthly to discuss timely news items or use the time to generate ideas for how you can take action to protect the animal kingdom within your own community. Another idea is to create a book club. Read and discuss other books that address the animal kingdom and conservation issues, including books like *The World as We Knew It: Dispatches from a Changing Climate* edited by Amy Brady and Tajja Isen; *Under a White Sky: The Nature of the Future* by Elizabeth Kolbert; *When Animals Dream: The Hidden World of Animal Consciousness* by David M. Peña-Guzmán; or *The Inner Life of Animals* by Peter Wohlleben.

4. Bring Awareness to Important Issues

Create a newsletter or social media account to educate others and bring awareness and attention to important issues pertaining to the animal kingdom and the environments they live in—as well as our responsibility to respect and protect them. Information about creating a newsletter using Google can be found at tinyurl.com/CreatingNewsletters and information about creating a social media account can be found at sproutsocial.com/insights/social-media-activism.

5. Create a Bird-friendly Environment

Consider how your environment affects the birds that live or pass through there during migration. You might use a tool such as ebird.org to find out what birds reside in your area and learn more about them or review live maps at birdcast.info/migration-tools/live-migration-maps to learn more about the birds that may be passing through. Take concrete actions to create a safer environment for the birds. This could range from creating birdbaths and proper bird feeders to “birdproofing” glass or planting native plants. More suggested ways to accomplish this can be found on the Audubon website (www.audubon.org/get-outside/activities) or The Cornell Lab of Ornithology (www.birds.cornell.edu/home/seven-simple-actions-to-help-birds).

ADDITIONAL RESOURCES

Interviews & Further Writings

- Ed Yong’s TED Talk, “Suicidal wasps, zombie roaches and other parasite tales”: tinyurl.com/YongTEDTalk
- Ed Yong speaks about *An Immense World* on the Barnes and Noble podcast *Poured Over*: tinyurl.com/YongPouredOver
- Ed Yong on “How Animals Sense the World” for Sean Carroll’s *Mindscape* podcast: tinyurl.com/YongMindscape
- Ed Yong speaks with CNN about light and sound pollution: tinyurl.com/YongCNN
- Ed Yong speaks about journalism, science writing, and his career—a conversation as part of New York University’s *Inside/Out* series: tinyurl.com/YongInsideOut
- “In *An Immense World* Ed Yong helps us perceive the world the way animals do” for WBUR.org: tinyurl.com/YongWBUR
- “The secret sensory world of animals” for KCRW.com, hosted by Jonathan Bastian: tinyurl.com/YongKCRW
- Ed Yong’s podcasts for *Science Friday*: www.sciencefriday.com/person/ed-yong

**ADDITIONAL RESOURCES
(CONTINUED)**

- Elizabeth Kolbert on “The Strange and Secret Ways That Animals Perceive the World” and Ed Yong’s book for *The New Yorker*: tinyurl.com/YongTNY
- Ed Yong’s portfolio of science writing for *The Atlantic*: www.theatlantic.com/author/ed-yong

Selected Reviews

- “‘An Immense World’ Is a Thrilling Tour of Nonhuman Perception” by Jennifer Szalai, *The New York Times*: tinyurl.com/ImmenseWorldNYT
- “‘An Immense World’ dives deep into the umwelt of animals” by Barbara J. King, NPR: tinyurl.com/ImmenseWorldNPR
- “Ed Yong’s *An Immense World* Examines What Lessons the Animal Kingdom Can Teach Us” by Hamilton Cain, *Oprah Daily*: tinyurl.com/ImmenseWorldOprahDaily
- “If only humans could sense the world the way animals do” by Sadie Dingfelder, *The Washington Post*: tinyurl.com/ImmenseWorldWP
- “Ed Yong on the wondrous world of animal senses” by Benjamin Thompson, *Nature*: tinyurl.com/ImmenseWorldNature
- “An Immense World by Ed Yong review – the astonishing ways in which animals experience our planet” by Killian Fox, *The Guardian*: tinyurl.com/ImmenseWorldGuardian
- “An Immense World: How Animal Senses Reveal the Hidden Realms Around Us,” *Publishers Weekly*: tinyurl.com/ImmenseWorldPW
- “Review: ‘An Immense World,’ by Ed Yong” by Hamilton Cain, *Star Tribune*: tinyurl.com/ImmenseWorldStarTribune
- “The Octopus Dreams of Crabs” by Laura Miller, *Slate*: tinyurl.com/ImmenseWorldSlate

ABOUT THIS GUIDE’S WRITER

Je Banach has written about books for *The Atlantic*, *The Paris Review*, *Granta*, *Oprah Daily*, *Bookforum*, *Lit Hub*, *Los Angeles Review of Books*, and other venues. She was an original member of the Yale Writers’ Workshop (fka Yale Writers’ Conference) faculty in fiction; in previous years she taught seminars on literary discourse and led a live Q&A session with *The New Yorker*’s fiction editor Deborah Treisman. A long-time contributor to Harold Bloom’s literary series with Infobase Publishing, Banach is the author of more than 100 guides to works of world literature.



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