USING FIGURES TO SUPPORT SCIENTIFIC TEXTS

WHY DO WE USE FIGURES?

Figures help readers understand, remember, and share

Figures enhance scientific writing by providing ways to understand important concepts and findings beyond the text of a manuscript. This pairing of text and images can more effectively convey a message than either images or text alone. Not only do figures make information easier to grasp, but they also make research easier to share. A good figure may take on a life of its own outside of a paper through reproductions and references in presentations, lectures, social media posts, or educational materials.

Figures make meaning from data

Complicated experimental workflows and outputs require time to understand and interpret accurately. Figures organize this complex information in readily digestible formats. Rather than leaving data interpretation entirely up to the reader, figures elucidate important patterns and trends through their design (see our handout on **Effective Figure Design** for suggestions). The organization and design strategies within a figure can even provide useful insight into how researchers think about their work.

Figures support scientific arguments

Research writing has a persuasive component: for new findings to be accepted into scientific knowledge, writers need to prove that their interpretations of their findings make sense and have significance for important questions in the field. Figures provide valuable evidence for these arguments by clarifying the research process and findings. For example, a figure might show how a novel method is efficient and well-controlled through a step-by-step flow chart or reveal the quality of experimental data including both variance and statistically significant trends.

Figure designers must always make choices about what to show and what not to show. Too many visualizations and too much data risks overwhelming and confusing readers and might violate journal page or figure limits. Writers carefully select figures that best answer their scientific questions, are necessary to show the validity of their findings, and are useful to their target audience. Similarly, they make decisions around how to organize and design each figure. This process can be somewhat subjective; any dataset could be portrayed in many ways, with each choice of format and area of emphasis influencing how the audience interprets the final product. The goal of the figure-making process is *truthful* representation that accurately represents the data while drawing on the tools of visual storytelling to help readers understand the authors' arguments.

MAKING FIGURES AND TEXT WORK TOGETHER

For figures to maximally support a scientific argument, they must work with, not against, the manuscript's text. Visuals and text each have unique strengths: while your text may be information-dense and filled with searchable, specific details necessary for understanding, validating, and repeating the work, your figures can pull out important ideas and trends and simplify complex topics, making the most significant ideas interpretable at a glance.

A complete figure, as modeled in the example at right, has several parts: the main image(s), a title indicating the topic of the figure, legends and labels necessary to interpret the image, and a detailed caption that explains the content. Importantly a figure should also have an **in-text citation** that links the image to the main text. For example, this figure is mentioned in the following passage in the paper:

"Over the past 3 years, we detected and located 54,319 earthquakes **(Fig. 2)**…Our phase-picking and association methods in particular enhanced the detection of low-magnitude and overlapping events. Furthermore, by using the double difference approach (25), with cross-correlation-based arrival times (26), and a 3D velocity model (27), we improved earthquake location precision to reveal a highly resolved view of CFc seismicity (**Figs. 2** and 3)."

This passage describes how the authors advanced understanding of earthquakes at their study site. Here Fig. 2 is cited as evidence to support the authors' conclusions, signaling to readers that they can see and evaluate the findings for themselves. Meanwhile, the caption for the image explains what the data *is* and where it came from, providing necessary context to read the plots in panels A and B. While both text and figure can be read alone, together they tell a clear and compelling story about the impact of the research.

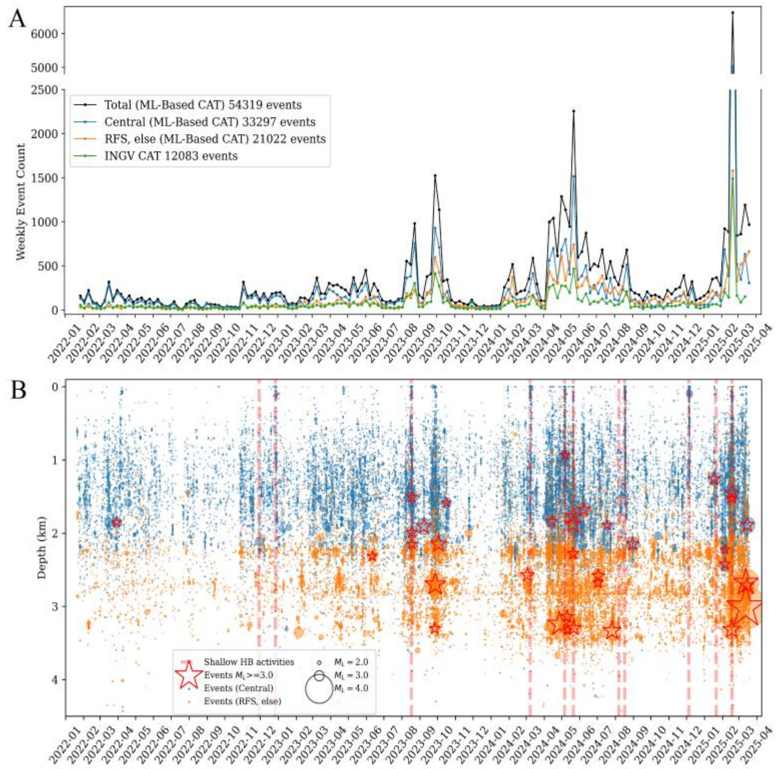


Fig. 2. Overview of the Campi Flegrei seismicity.
(**A**) Seismicity rate computed with the relocated ML-based catalog and INGV-OV routine catalog (*24*). Curves show the seismicity rate of the central region (blue) and RFS plus other regions (orange). These two regions are separated by the dashed borders in Fig. 3. Detection was particularly improved during major swarms. (**B**) Relocated ML-based earthquake depth distribution over time, with event magnitude denoted by the size of the dot. Horizontal lineations result from persistent depth-limited seismicity across different sectors (also seen in Fig. 3). 0 km marks sea level. Near-surface seismicity (0–0.5 km) is concentrated in the Accademia lava dome, while shallow seismicity (0.5–2.1 km) mostly occurs in the Pozzuoli-Solfatara-Pisciarelli-Agnano region. Seismicity is also observed at depths of 2.1–2.5 km in the northern sector of the RFS, 2.5–3.0 km in the eastern sector, and 2.5–3.7 km in the southwestern sector. Events reported below 3.7 km are uncertain and likely located this deep due to inaccurately measured arrival times (see supplementary materials). Shallow hybrid events (figs. S14 and S15) are denoted with red slashed lines.

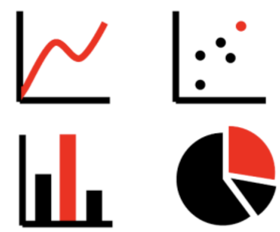
Source: Tan 2025 (DOI: 10.1126/science.adw9038)

CHOOSE THE RIGHT FIGURE FOR YOUR MESSAGE

The first step to making an effective figure is choosing a format suitable for the message you wish to convey. Every type of visual has strengths and weaknesses. Before creating a figure, determine what you want the viewer to take away and consider what type of graphic will make this message clear.

Summaries at a glance: graphical abstracts and model figures

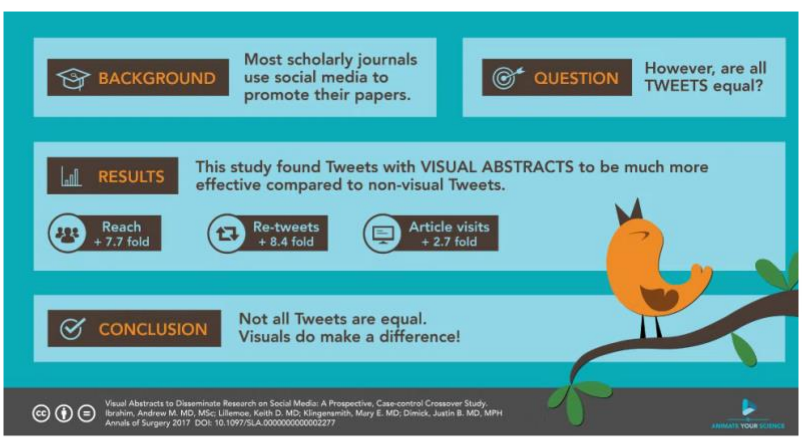
Some figures provide global summaries of a research project. For example, **graphical abstracts** are required by some journals for publication. These figures, posted alongside the text of the abstract, **capture the essence of your research questions and findings** and provide a simple, clear entry point to your work for readers outside your field.

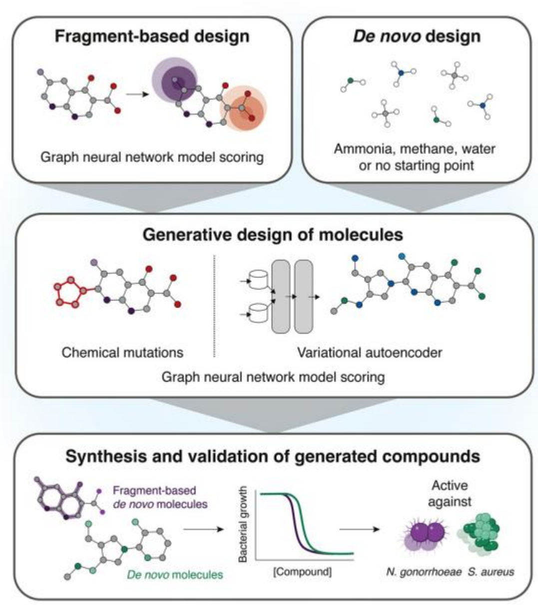


These graphical-abstract friendly plots are easy to understand and draw attention to important elements such as a trend, key datapoint, or a sample of interest. Source: Jambor 2024 (DOI: 10.1371/journal.pcbi.1011789)

Graphical abstracts also function as promotional material for your work. An eye-catching, informative image can draw potential readers to your writing and may be shared by the journal (or you) to showcase your findings to the broader community. Some studies have found that circulating graphical abstracts on social media increases views for scientific papers (Oska 2020, Ibrahim 2017).

Since graphical abstracts might be the first thing a potential reader sees of your work, it is critical to **design these figures for rapid comprehension without context from the rest of the paper.** A good graphical abstract conveys the most important finding(s) of your work at a high level: think elevator pitch to an acquaintance, not technical report for your research group. These figures often have clear and unified design schemes that emphasize important relationships and key findings as intuitively as possible. Simple backgrounds, fonts, and images with good contrast reduce noise and increase aesthetic appeal. Some graphical abstracts are designed like mini posters, while others simply highlight a key result. Some are intended for a specific specialist audience while others are geared toward the general public. When making a graphical abstract, consider your communication goals and choose the format that best fits your purpose and format.



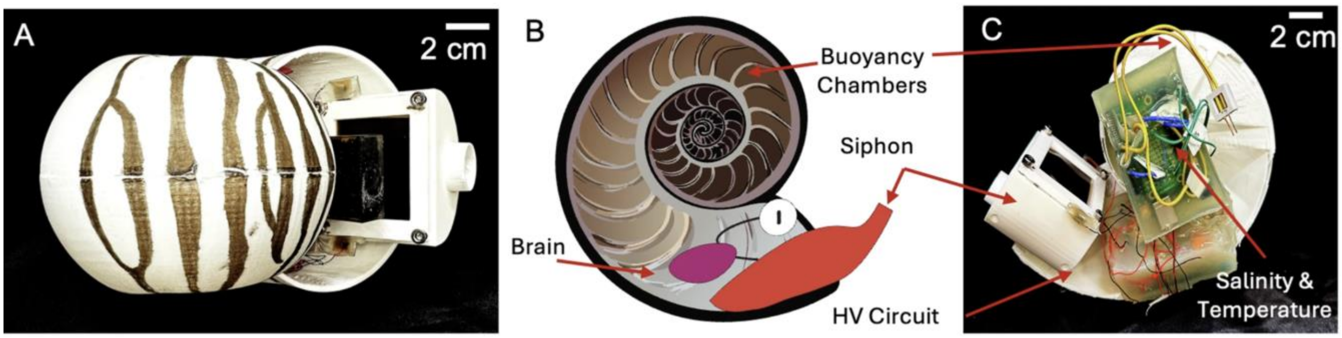


Two examples of graphical abstracts for a broad audience (above) and specialist audience (right). From: Balbin 2021 (above), Krishnan 2025 DOI: 10.1016/j.cell.2025.07.033 (right).

Documenting reality: photographs & more

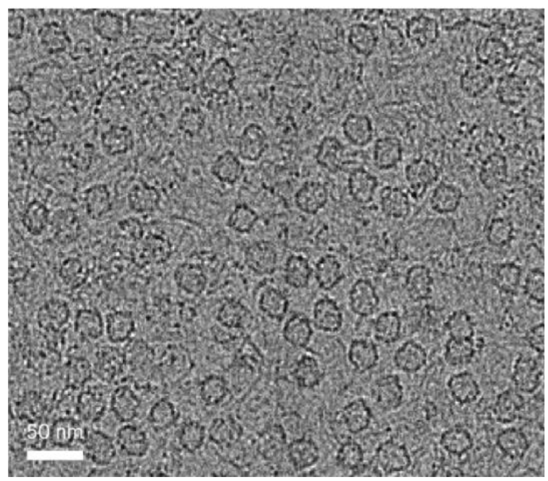
Photographs and other types of direct experimental images fill many rhetorical roles in scientific texts: they accurately depict the experimental process, build trust through transparency, and invite the audience to interpret data with you.

Photographs help readers understand the physical space in which you work and translate complicated designs or data into real-world meaning. They are sometimes paired with diagrams to show how a simplified representation of key components translates to a three-dimensional physical object.



The photographs in panels A and C reveal how the basic features of a natural nautilus (panel B) are translated into the structure of the authors' "RoboNautilus." From: Flores 2025 ([DOI: 10.1038/s44182-025-00035-2](https://doi.org/10.1038/s44182-025-00035-2))

Some images support scientific arguments by revealing the quality of underlying data. For example, the "micrograph" at right, taken with an electron microscope, is part of a larger collection of images used to develop a 3D molecular model. Since the conclusions of this research rely on a complex image processing workflow, sharing examples of the starting micrographs builds audience confidence in the paper's findings by showing that the work began with high-quality data. Where a plot or table can capture trends, averages, and statical information about your findings, an image lets the audience see what you saw in its full complexity and make their own observations: Are outliers meaningful? Did you focus on the right thing? Might there be error due to lower-quality data, or might your findings be influenced by a specific technique or tool you used? Are there any surprising features that can't be described or accounted for with an error bar on a graph?



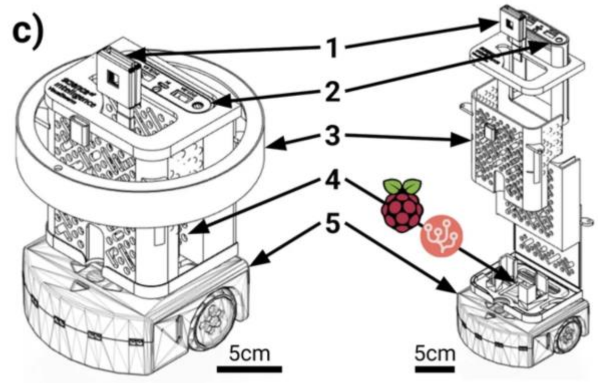
An electron micrograph shows that the sample and microscope were optimized to produce high-quality data. From Zhang 2025 ([DOI: 10.1038/s41594-025-01650-1](https://doi.org/10.1038/s41594-025-01650-1))

To prevent the audience from being misled about the quality of the data, choose images that are representative of the full dataset or a typical experimental run rather than cherrypicking the "best" image. Images should also have good contrast and focus on the items of interest, with minimal background "noise." For example, if you are taking a picture of a device you made, the device should be centered in the image with a clean, simple background rather than your messy desk!

Clarifying design: diagrams and schematics

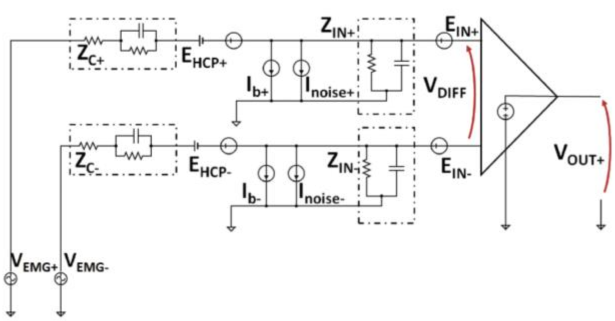
Diagrams and schematics reveal structural details and explain design strategies. They are also sometimes used to provide a visual guide to experimental layout or enhance instructions to readers for how to produce something themselves.

Unlike photographs, diagrams simultaneously capture multiple views while eliminating distracting details. They can also **show perspectives unachievable by eye** such as cross-sections or slices through objects of interest that reveal interior and exterior views from useful angles.



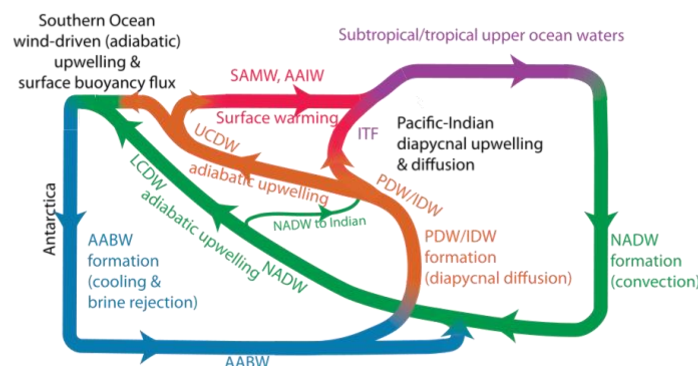
This diagram shows the audience key internal and external features of a robot and how they fit together. From: Mezey 2025 ([DOI: 10.1038/s44182-025-00027-2](https://doi.org/10.1038/s44182-025-00027-2))

Diagrams vary in how "true to life" they are. When a figure is intended for viewers to interpret and reconstruct a structure themselves (for example, images accompanying assembly instructions or technical specifications), extra detail, careful labeling, and perspectives that accurately reflect dimensionality may be critical. These figures may use standardized colors, symbols, and layouts interpretable by expert audiences. In cases where the exact physical layout is less important than the relationships between parts, a less detailed diagram may be easier to read (think of transit maps that show how bus or subway lines connect throughout a city but eliminate some of the twists and turns of the routes from stop to stop).



(a) Electrical diagram of the tissue-electrode model.

An electrical diagram using established notation in the field. From: Benatti 2025 (DOI: [10.1109/JPROC.2025.3581995](https://doi.org/10.1109/JPROC.2025.3581995)).

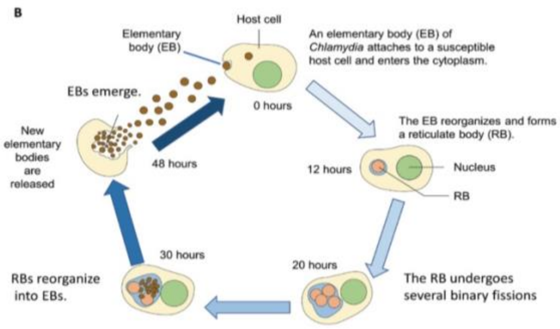


A simpler "transit map" style diagram of global ocean circulation patterns. From: Talley 2015 ([DOI: 10.5670/oceanog.2013.07](https://doi.org/10.5670/oceanog.2013.07)).

When designing a diagram, consider its purpose: to clarify concepts, or to provide specific structural detail? A useful diagram simplifies its content as much as possible by eliminating details irrelevant to achieving its purpose. Perspective and layout decisions should be considered carefully to balance high visibility of important components with accurate interpretation. Good diagrams use simple but functional design strategies appropriate to the audience: for example, the left figure above uses simple geometric shapes and lines as well as symbols familiar to an expert audience to compactly convey information. The figure at right uses a color gradient to make the direction of flow clear through the intersecting pathways and sacrifices geographical precision for an easy-to-read layout.

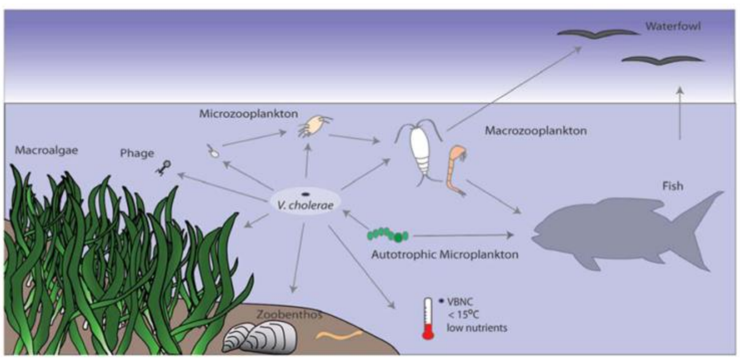
Explaining process: flow charts

Flow charts are a type of diagram that **shows relationships within multistep processes.** These figures provide visual support for complex workflows and break down complex processes into easy-to-follow steps.



This figure uses gradient colors in the arrows to emphasize the direction of flow. From: Kimber 2018 (DOI: 10.1128/jmbe.v19i1.1477)

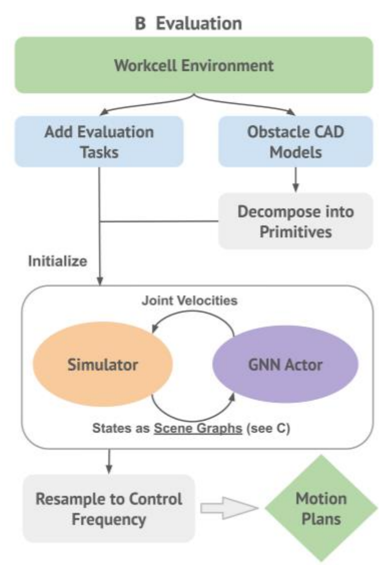
Flow charts emphasize the movement from item to item or step to step rather than individual components themselves. Whenever possible images are spatially organized to reflect the directionality and hierarchy between components. For example a cyclical process may be represented by a circle, while linear or simple branching paths are organized from left to right or top to bottom with clear starting/ending points. The images in flow charts are generally simplified, showing only the details relevant to the process. For example, the flow chart above eliminates most structures inside the cell and uses simple shapes and colors to show how relevant features change over time.



This flowchart uses illustrations to convey additional information about the relationships it depicts. From: Lutz 2013 (DOI: 10.3389/fmicb.2013.00375)

Some flow charts depict branching and complex pathways. These figures sometimes use color coding, highlights, or other visual elements to help readers interpret the flow. For example, the "food web" at left shows how pathogenic *Vibrio cholerae* spreads through the environment. The light-colored oval around *V. cholerae* indicates that this is the focus or starting point of the diagram, while other organisms are arranged to reflect their habitat (from top to bottom: air, surface waters, deeper water, aquatic sediments).

Not all flow charts need to be this graphically complex. Other strategies to help readers follow the flow include using simple shapes or colors to distinguish different phases or categories. The flow chart at right uses only simple text boxes and arrows but effectively reveals key stages of the workflow, including tasks happening in parallel (blue boxes), cyclical processes (yellow and purple, isolated from the other steps in a box), and outputs (green diamond). Effective flow charts also draw on established "design vocabulary" by using symbols and styles common in published figures in the field. Making design choices that will be familiar to readers of similar work reduces how much new information your audience needs to learn to understand your figure.



A simple flow chart, from: Lai 2025 (DOI: 10.1126/scirobotics.ads120)

Flow charts can be especially helpful in grant proposals, which are often evaluated for feasibility, impact, and scientific rigor. An eye-catching, well-designed flow chart can help reviewers (who may be comparing and scoring many proposals in one sitting) understand the logic of the proposed project.

Making patterns visible: results figures

In scientific writing, most figures focus on results. **Results figures support the text descriptions of research findings by elucidating patterns, trends and key findings and making complex data rapidly digestible through visual design.** While there are many types of result figures and specific design expectations vary from field to field, they often have one or more of the following rhetorical goals:

Make comparisons: Some figures are designed to *make comparisons* between different samples, time points, trials, etc. To facilitate interpretation, these figures place items being compared side-by-side and use designs that are scaled to clearly and accurately show the differences between values.

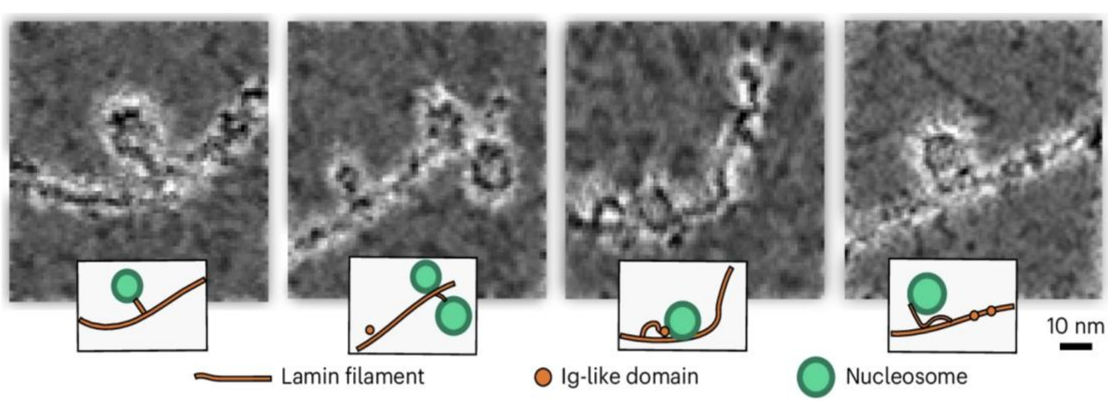
Show composition: Some figures demonstrate the composition of a whole or make visible the fraction or percentage a specific sample or response makes up of a whole. Some types of composition plots include stacked bar charts, pie charts, or waffle charts.

Show distribution: Other figures show distributions across a range of values. These include histograms, box plots, density plots, and ridgeline plots.

Correlate: When interested in relationships between two or more parameters figures such as scatter plots are used. Similarly, some figures such as line charts **track changes in a variable over time.**

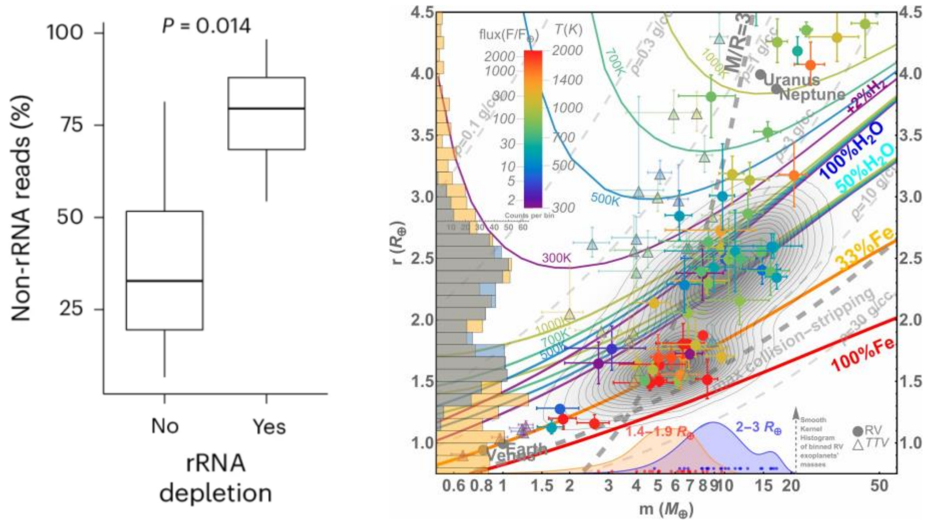
Organize by hierarchy: Some figures show linkages between parts of dataset or organize items into categories based on their relationships. Examples include sunburst diagrams and network diagrams.

Some figures achieve more than one goal by combining multiple simple and visually distinct elements into one figure: Multiple goals can be achieved by a single plot type; for example, butterfly charts can show change over time AND make comparisons between two categories. In other cases, multiple image types are combined to achieve an effect. In the example below, the authors combined images from their experiment (in this case, electron microscopy micrographs) with small cartoon representations to help the reader interpret the noisy data. This strategy can be especially useful when you are showing data your reader may be unfamiliar with or to help a reader draw connections between experimental observations and the broader model or framework they support.



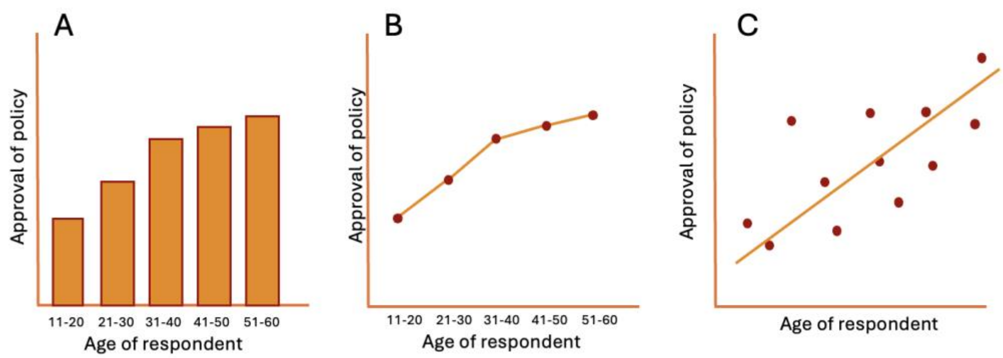
Cartoon depictions provide a guide to interpreting the experimental images. From Wang 2025 ([DOI: 10.1038/s41594-025-01622-5](https://doi.org/10.1038/s41594-025-01622-5))

Importantly, **all data combined in a single figure should work together to tell a single story.** The box plots (left) provide information about the variation in each treatment group ("no" and "yes" rRNA depletion) as well as the differences *between* each group. Together these insights tell the same story about what happens when rRNA depletion is done. In contrast, the right figure overlaps a wide variety of findings on the same plot. This plot is not only crowded but difficult to interpret because each component answers a different question. The variety of data presentations make it difficult to know what, if anything, can be compared.



Left from Chia 2025 ([DOI: 10.1038/s41587-025-02797-4]), right from Zeng 2019 ([DOI: 10.1073/pnas.181290511])

Since each figure type is optimized for specific rhetorical functions, the choices you make in presenting your data influence how viewers interpret your findings. For example, imagine you surveyed a group of people of varying age about their opinions on a specific policy. Plots A and B below show two ways to plot the results. While the bar chart **(A)** clearly shows the differences in opinion between respondents of distinct age categories, the line graph **(B)** is more ambiguous. Is it saying that approval of the policy changes over the lifespan of an individual, or that people of different ages polled at the same time have different opinions? Alternatively, a scatter plot with a trendline **(C)** might be useful if you want to show both individual responses and the general trend, perhaps because you want to discuss both the variations in the responses and the overall trend.

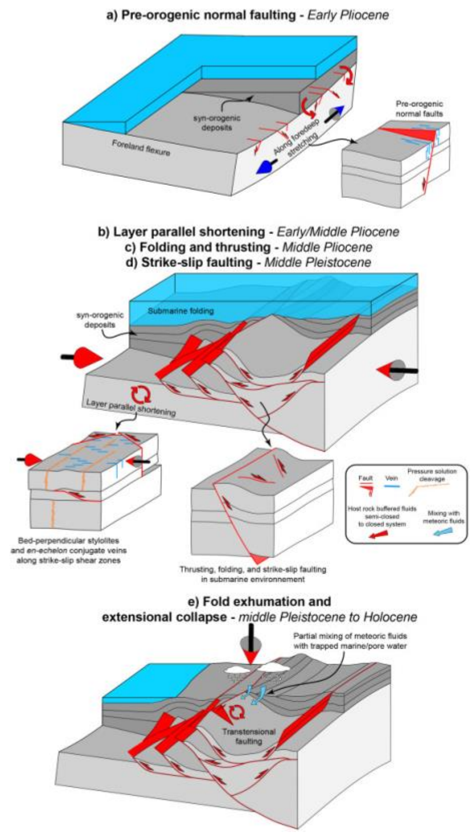


In general, a visualization distills raw data into a more rapidly-understood format. While this simplicity helps viewers grasp important patterns, it also prevents them from rapidly checking whether the patterns are meaningful or match the raw data. To help your readers assess the significance of your findings, **consider how different visualization styles may allow you to portray the variation in your data or the results of statistical tests.** Can you include error bars? Indicate how well your trendline fits your data? Include information about replicates?

Capturing the big idea: concept or model illustrations

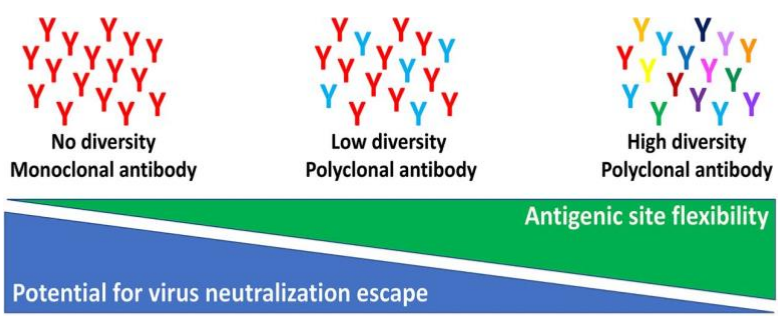
Concept or model illustrations **provide visually engaging support for text explanations of key hypotheses, proposed models, and other big ideas** by distilling large amounts of information into an easily digestible image. These figures take many forms, including simple cartoons, elaborate illustrations, and text-and-image graphics. Flow charts and diagrams also sometimes fill the "model illustration" rhetorical role when the major takeaway from a project has to do with structure or process.

While concept illustrations can appear in any section of a paper where a visual aid might make important ideas easier to understand, they are most common in introduction and discussion sections. In introduction sections, concept figures can **organize foundational ideas and questions**. In discussion sections, these figures **integrate multiple lines of evidence from the results, along with prior knowledge, into broader conclusions or new models of understanding.** For example, the figure at right proposes an explanation for how a geological feature formed by synthesizing field work and experimental data. Rather than showing individual results, this figure reveals the bigger "story" suggested by the evidence.



This example from Smeraglia 2025 (DOI: 10.1016/j.jsg.2025.105502) proposes an explanation for how a geological feature formed. This model synthesizes the authors' field work and experimental data to reveal the geological "story" suggested by the evidence.

At their simplest, concept illustrations can draw on established design vocabulary to make concepts more intuitive. The figure below, for example, describes the authors' hypothesis about vaccine design. Even without understanding the science, the area occupied by "virus neutralization escape" shrinking as the area occupied by "antigenic site flexibility" grows can be readily interpreted as two opposing characteristics. Meanwhile increasing antibody diversity is visually represented by increasingly multicolored symbols. Free from the messiness and detail of real data, this illustration makes the underlying concept understandable at a glance.



A simple illustration can intuitively convey important concepts. From: Fedechkin 2020 (DOI: 10.1128/JVI.01879-19).

RESOURCES AND WORKS CONSULTED:

Balbin, Miguel (2021). How to Design an Effective Graphical Abstract: The Ultimate Guide. Animate Your Science. https://www.animateyour.science/post/how-to-design-an-effective-graphical-abstract-the-ultimate-guide.

Design Handbook: Engineering Drawing and Sketching. MIT OpenCourseWare. https://ocw.mit.edu/courses/2-007-design-and-manufacturing-i-spring-2009/pages/related-resources/drawing_and_sketching/.

Engineering Working Drawings Basics. https://s3vi.ndc.nasa.gov/ssri-kb/static/resources/Engineering+Working+Drawing+Basics.pdf.

Hughes, Ken (2017). To Make a Good Schematic, Copy, Adapt, and Refine." Brushing up Science. https://brushingupscience.com/2017/08/15/to-make-a-good-schematic-copy-adapt-and-refine/.

Hughes, Ken (2021). Transit Map–Style Scientific Figures. Brushing up Science. https://brushingupscience.com/2021/02/09/transit-map-style-scientific-figures/.

Ibrahim A.M., Lillemoe K.D., Klingensmith M.E., Dimick J.B. (2017). Visual Abstracts to Disseminate Research on Social Meida: A Prospective, Case-control Crossover Study. *Annals of Surgery.* DOI: 10.1097/SLA.0000000000002277

Jambor, H.K., and Bornhäuser, M. (2024). Ten Simple Rules for Designing Graphical Abstracts. *PLOS Computational Biology*. *DOI: 10.1371/journal.pcbi.1011789*

Kimber O., Cromley J.G., Molnar-Kimber K.L. (2018). Let Your Ideas Flow: Using Flowcharts to Convey Methods and Implications of the Results in Laboratory Exercises, Articles, Posters, and Slide Presentations. *Journal of Microbiology & Biology Education*. DOI: 10.1128/jmbe.v19i1.1477

Oska S., Lerma E., Topf J. (2020). A Picture Is Worth a Thousand Views: A Triple Crossover Trial of Visual Abstracts to Examine Their Impact on Research Dissemination. doi: 10.2196/22327

OTHER SOURCES OF EXAMPLE FIGURES:

Benatti S., Donati E., Moin A., et. al. (2025). EMG Acquisition and Processing for Hand Movement Decoding on Embedded Systems: State of the Art and Challenges. DOI: 10.1038/s44182-025-00027-2

Chia M., Ng A.H.Q., Ravikrishnan A., et. al. (2025). Skin metatranscriptomics reveals a landscape of variation in microbial activity and gene expression across the human body. *Nature Biotechnology.* DOI: 10.1038/s41587-025-02797-4

Fedechkin S.O., George N.L., Nuñez Castrejon A.M., et. al. (2020). Conformational Flexibility in Respiratory Syncytial Virus G Neutralizing Epitopes. *Journal of Virology.* DOI: 0.1128/jvi.01879-19

Flores D., Sandhu S., White A., et. al. (2025). RoboNautilus: a cephalopod-inspired soft robotic siphon for underwater propulsion. *NPJ Robotics.* DOI: 10.1038/s44182-025-00035-2

Krishnan A., Anahtar M.N., Valeri J.A., et. al. (2025). A generative deep learning approach to *de novo* antibiotic design. *Cell.* DOI: 10.1016/j.cell.2025.07.033

Lai M., Go K., Li Z., et. al. (2025) RoboBallet: Planning for multirobot reaching with graph neural networks and reinforcement learning. *Science Robotics.* DOI: 10.1126/scirobotics.ads1204

Lutz C., Erken M., Noorian P., et. al. (2013). Environmental reservoirs and mechanisms of persistence of Vibrio cholerae. *Frontiers in Microbiology*. DOI: 10.3389/fmicb.2013.00375

Mezey D., Bastien R., Zheng Y., et. al. (2025). Purely vision-based collective movement of robots. *NPJ Robotics.* DOI: 10.1038/s44182-025-00027-2

Smeraglia L., Aldegada L., Bernasconi S.M., et. al. (2025). Structural and stratigraphic control on fluid flow in the Mt. Conero anticline, Italy: An analog for offshore resource reservoirs in fold-and-thrust belts. *Journal of Structural Geology.* DOI: 10.1016/j.jsg.2025.105502

Talley, L. (2015). Closure of the Global Overturning Circulation Through the Indian, Pacific, and Southern Oceans: Schematics and Transports. *Oceanography. DOI: 10.5670/oceanog.2013.07*

Tan X., Tramelli A., Gammaldi S., et. al. (2025). A clearer view of the current phase of unrest at Campi Flegrei caldera. *Science*. DOI: 10.1126/science.adw9038

Wang B., Kronenberg-Tenga R., Rosti V., et. al. (2025). The molecular basis of lamin-specific chromatin interactions. *Nature Structural & Molecular Biology.* DOI: 10.1038/s41594-025-01622-5

Zhang S., Yi R., An L., et. al. (2025). Structural insights into higher-order natural RNA-only multimers. *Nature Structural & Molecular Biology.* DOI: 10.1038/s41594-025-01650-1

Zeng L., Jacobsen S.B., Sasselov D.D., Wordsworth R.D. (2018). Growth model interpretation of planet size distribution. *Procedings of the National Academy of Sciences.* DOI: 0.1073/pnas.1812905116