
Measles: A Complete Learning Guide

Sources & References

This handout lists every source cited across the eight learning modules and the interactive timeline of the Measles: A Complete Learning Guide web application. Every factual claim in the app is grounded in these references — drawn from the CDC, WHO, peer-reviewed journals, and authoritative medical-history sources. All links are live and clickable so any reader can independently verify the material.

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Live app: <https://coding.epidemiological.net/measles-learn/>

Repository: <https://github.com/RFNajera/measles-learn>

Content accurate as of July 2026. Educational content — not medical advice.

About these sources

The content of this app was researched from primary and authoritative sources and then independently fact-checked against those sources. Where reputable sources disagree, the app notes the discrepancy rather than papering over it. Two such points are documented below.

Source hierarchy

- Public health agencies — U.S. CDC, WHO, ECDC, and the Public Health Agency of Canada for epidemiology, clinical, and virological facts.
- Peer-reviewed literature — Science, The Lancet, BMJ, Annals of Internal Medicine, Clinical Infectious Diseases, and others for primary research findings.
- Medical-history sources — reprints of Panum (1846), Black (1966), the Hilleman memoir, and contemporary accounts for the historical record.

Documented points of source disagreement and nuance

1. David Edmonston's age in 1954. Contemporary accounts and Edmonston's own 2025 recollection give his age as 11 when Thomas Peebles drew the blood sample that yielded the Edmonston strain; some later sources (including the current CDC history page) say 13. The app uses 11 and cites the primary and contemporary sources.
2. The 2019 U.S. case count. Early 2020 summaries reported 1,282 cases; the CDC's current final figure is 1,274. The app uses the CDC's final number.
3. The CDC's autism-vaccine webpage (November 2025). The CDC changed its long-standing "vaccines do not cause autism" page to call that statement "not an evidence-based claim." This was a policy/wording change, not a new scientific finding: the large cohort studies (including Hviid et al.'s 657,461-child study) that find no link are unchanged. The Myths module cites both the CDC page and the underlying research so readers can weigh them directly.

A note on SSPE risk figures: subacute sclerosing panencephalitis risk estimates vary by the age denominator used (under age 2 vs. under age 5) and by study population. The app therefore presents SSPE risk as a range with the caveat that risk rises the younger the child is at infection.

Sources by learning module

Module 1 — Origins & Emergence

- 1 Düx et al., Science (2020) — measles–rinderpest divergence
<https://www.science.org/doi/10.1126/science.aba9411>
- 2 Furuse et al., Virology Journal (2010)
<https://d-nb.info/1098729005/34>
- 3 Black, Journal of Theoretical Biology (1966) — critical community size
<https://andreashandel.github.io/IDEMAcourse/media/black66jtb.pdf>
- 4 CDC — History of Measles
<https://www.cdc.gov/measles/about/history.html>
- 5 Muslim Heritage — Al-Razi on Smallpox and Measles
<https://muslimheritage.com/al-razi-smallpox-measles/>
- 6 SAMJ (2010) — early history of measles (Fracastoro, Sydenham)
https://scielo.org.za/scielo.php?script=sci_arttext&pid=S0256-95742010000400013
- 7 Médecine et Maladies Infectieuses (2022) — Sydenham and the clinical description of measles
<https://www.sciencedirect.com/science/article/abs/pii/S0755498222000422>
- 8 MSK Library Guides — History of Measles (Francis Home)
<https://libguides.mskcc.org/publichealth/MeaslesHistory>
- 9 WHO — History of Measles Vaccination
<https://www.who.int/news-room/spotlight/history-of-vaccination/history-of-measles-vaccination>

Module 2 — Virology

- 1 PHAC — Measles Virus Pathogen Safety Data Sheet
<https://www.canada.ca/en/public-health/services/laboratory-biosafety-biosecurity/pathogen-safety-data-sheets-risk-assessment/measles-virus.html>
- 2 Mina et al., Science (2019) — immune amnesia
<https://www.science.org/doi/10.1126/science.aay6485>
- 3 CDC Pink Book, Chapter 13 — Measles
<https://www.cdc.gov/pinkbook/hcp/table-of-contents/chapter-13-measles.html>
- 4 WHO Immunological Basis for Immunization Series (2020)
https://files.givewell.org/files/DWDA%202009/WHO/WHO_Immunological_Basis_for_Immunization_Series_Measles_2020.pdf
- 5 NIH Director's Blog (2019) — how measles leaves the body prone to infection
<https://directorsblog.nih.gov/2019/11/12/how-measles-leaves-the-body-prone-to-future-infections/>

Module 3 — Clinical Disease & Societal Impact

- 1 CDC — Clinical Overview of Measles
<https://www.cdc.gov/measles/hcp/clinical-overview/index.html>
- 2 WHO — Measles Fact Sheet
<https://www.who.int/news-room/fact-sheets/detail/measles>
- 3 CDC — Measles Signs & Symptoms
<https://www.cdc.gov/measles/signs-symptoms/index.html>
- 4 ECDC — Measles Facts
<https://www.ecdc.europa.eu/en/measles/facts>
- 5 Pathogens and Global Health (2015) — Indigenous mortality
<https://pmc.ncbi.nlm.nih.gov/articles/PMC4768625/>

Module 4 — Epidemiology — Past

- 1 CDC — History of Measles
<https://www.cdc.gov/measles/about/history.html>
- 2 WHO — Measles Fact Sheet
<https://www.who.int/news-room/fact-sheets/detail/measles>
- 3 Panum, American Journal of Public Health (reprint)
<https://pmc.ncbi.nlm.nih.gov/articles/PMC1530953/>
- 4 Journal of Pacific Studies (2023) — Epidemics in Fiji's history
<https://www.usp.ac.fj/journal-of-pacific-studies/wp-content/uploads/sites/162/2023/12/Epidemics-in-Fijis-history.pdf>

Module 5 — Epidemiology — Current

- 1 WHO — Measles Fact Sheet (updated Nov 2025)
<https://www.who.int/news-room/fact-sheets/detail/measles>
- 2 WHO (2020) — worldwide measles deaths climb 50%
<https://www.who.int/news/item/12-11-2020-worldwide-measles-deaths-climb-50-from-2016-to-2019-claiming-over-207-500-lives-in-2019>
- 3 CDC — Measles Cases and Outbreaks (final 2019 count of 1,274 and 2025 data)
<https://www.cdc.gov/measles/data-research/index.html>
- 4 CDC MMWR (April 2025) — 2025 outbreak and first pediatric deaths since 2003
<https://www.cdc.gov/mmwr/volumes/74/wr/mm7414a1.htm>
- 5 Lancet (2024) — deaths averted by vaccination
<https://pmc.ncbi.nlm.nih.gov/articles/PMC11140691/>
- 6 KFF — Measles elimination status
<https://www.kff.org/other-health/measles-elimination-status-what-it-is-and-how-the-u-s-could-lose-it/>

Module 6 — Vaccine Development History

- 1 CDC — History of Measles
<https://www.cdc.gov/measles/about/history.html>
- 2 WHO — History of Measles Vaccination
<https://www.who.int/news-room/spotlight/history-of-vaccination/history-of-measles-vaccination>
- 3 National Academies — Maurice Hilleman biographical memoir
<https://www.nasonline.org/wp-content/uploads/2024/06/hilleman-maurice.pdf>
- 4 Los Angeles Times (2010) — Thomas Peebles obituary (David Edmonston, age 11)
<https://www.latimes.com/local/obituaries/la-me-thomas-peebles-20100813-story.html>
- 5 PBS NewsHour (2025) — David Edmonston recalls being 11 at the time
<https://www.pbs.org/newshour/show/man-whose-blood-helped-develop-measles-vaccine-weighs-in-on-recent-outbreak>
- 6 BMJ (2011) — Wakefield's article was fraudulent
<https://www.bmj.com/content/342/bmj.c7452>
- 7 Indian Journal of Psychiatry (2011) — the Wakefield affair
<https://pmc.ncbi.nlm.nih.gov/articles/PMC3136032/>

Module 7 — A Place Without Vaccines

- 1 WHO/UNICEF — Pacific Measles Outbreak Situation Reports (2019–2020)
https://www.who.int/docs/default-source/wpro---documents/dps/outbreaks-and-emergencies/measles-2019/20200122-measles-pacific-who-unicef-sitrep-11.pdf?sfvrsn=9e1851f5_2
- 2 The Lancet Infectious Diseases — Samoa measles outbreak
[https://www.thelancet.com/journals/laninf/article/PIIS1473-3099\(20\)30053-0/abstract](https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30053-0/abstract)
- 3 The Lancet (Thornton, 2020) — outbreak and aftermath
<https://pmc.ncbi.nlm.nih.gov/articles/PMC7255155/>
- 4 Journal of Global Health (2020) — coverage collapse and toll
<https://pmc.ncbi.nlm.nih.gov/articles/PMC7533430/>
- 5 BBC News — how misinformation took hold
<https://www.bbc.com/news/world-asia-50625680>
- 6 The Guardian — how the outbreak took hold
<https://www.theguardian.com/world/2019/dec/18/these-babies-should-not-have-died-how-the-measles-outbreak-took-hold-in-samoa>
- 7 NPR — government shutdown for mass vaccination
<https://www.npr.org/2019/12/02/784179707/samoan-government-to-close-its-offices-amid-measles-crisis-that-has-left-53-dead>
- 8 1News NZ — court findings on the 2018 administration error
<https://www.1news.co.nz/2019/08/02/nurses-sentenced-to-five-years-in-prison-for-incorrectly-administering-mmr-vaccine-that-led-to-deaths-of-two-infants-in-samoa/>

- 9 Doherty Institute — measles in Samoa
<https://www.doherty.edu.au/articles/measles-in-samoa-in-the-grips-of-an-outbreak-disaster/>

Module 8 — Myths & Misconceptions

- 1 Hviid et al., Annals of Internal Medicine (2019) — 657,461-child cohort, no MMR–autism link
<https://www.acpjournals.org/doi/10.7326/M18-2101>
- 2 CDC — Autism and Vaccines
<https://www.cdc.gov/vaccine-safety/about/autism.html>
- 3 Mina et al., Science (2019) — measles immune amnesia
<https://www.science.org/doi/10.1126/science.aay6485>
- 4 CDC — Measles Complications
<https://www.cdc.gov/measles/symptoms/complications.html>
- 5 CDC — Vaccine Ingredients (thimerosal, aluminum, formaldehyde)
<https://www.cdc.gov/vaccine-safety/about/ingredients.html>
- 6 CHOP Vaccine Education Center — vaccine ingredients and the dose-makes-the-poison principle
<https://www.chop.edu/vaccine-education-center/vaccine-ingredients>
- 7 WHO — Measles Fact Sheet
<https://www.who.int/news-room/fact-sheets/detail/measles>
- 8 CDC — Measles Cases and Outbreaks (2025)
<https://www.cdc.gov/measles/data-research/index.html>
- 9 BMJ (2011) — Wakefield's article was fraudulent
<https://www.bmj.com/content/342/bmj.c7452>

Sources for the interactive timeline

Year	Event & source
~528 BCE	Measles diverges from rinderpest Düx et al., Science (2020)
~900 CE	Rhazes describes measles Muslim Heritage
1757	Francis Home shows measles is infectious WHO — History of Measles Vaccination
1846	Panum's Faroe Islands study AJPH reprint
1875	The Fiji virgin-soil catastrophe Journal of Pacific Studies (2023)
1912	Measles becomes notifiable in the U.S. CDC — History of Measles
1954	Enders & Peebles isolate the virus CDC — History of Measles
1963	First measles vaccine licensed WHO — History of Measles Vaccination
1968	Hilleman's Moraten strain National Academies — Hilleman memoir
1971	MMR combination vaccine Merck company history
1974	WHO launches the EPI WHO EPI 50th anniversary
1989	Second MMR dose recommended CDC — History of Measles
1998	The Wakefield paper is published Indian Journal of Psychiatry (2011)
2000	U.S. declares measles eliminated CDC — History of Measles
2010	Wakefield paper retracted; author struck off BMJ (2011)

Year	Event & source
2019	Immune amnesia quantified Mina et al., Science (2019)
2019	Global & U.S. resurgence WHO (2020)
2019–20	Samoa: a place without vaccines The Lancet (2020)
2020	Measles origins pushed back Düx et al., Science (2020)
2024	59 million deaths averted WHO Fact Sheet (Nov 2025)
2025	Largest U.S. resurgence since 1992 CDC — Measles Cases and Outbreaks
2025	CDC autism-vaccine webpage altered CDC — Autism and Vaccines

Complete reference list

62 unique sources, alphabetized by publisher/author.

- 1 1News NZ — court findings on the 2018 administration error
<https://www.1news.co.nz/2019/08/02/nurses-sentenced-to-five-years-in-prison-for-incorrectly-administering-mmr-vaccine-that-led-to-deaths-of-two-infants-in-samoa/>
- 2 AJPH reprint
<https://pmc.ncbi.nlm.nih.gov/articles/PMC1530953/>
- 3 BBC News — how misinformation took hold
<https://www.bbc.com/news/world-asia-50625680>
- 4 Black, Journal of Theoretical Biology (1966) — critical community size
<https://andreashandel.github.io/IDEMAcourse/media/black66jtb.pdf>
- 5 BMJ (2011)
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- 9 CDC — Autism and Vaccines
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- 10 CDC — Clinical Overview of Measles
<https://www.cdc.gov/measles/hcp/clinical-overview/index.html>
- 11 CDC — History of Measles
<https://www.cdc.gov/measles/about/history.html>
- 12 CDC — Measles Cases and Outbreaks
<https://www.cdc.gov/measles/data-research/index.html>
- 13 CDC — Measles Cases and Outbreaks (2025)
<https://www.cdc.gov/measles/data-research/index.html>
- 14 CDC — Measles Cases and Outbreaks (final 2019 count of 1,274 and 2025 data)
<https://www.cdc.gov/measles/data-research/index.html>
- 15 CDC — Measles Complications
<https://www.cdc.gov/measles/symptoms/complications.html>
- 16 CDC — Measles Signs & Symptoms
<https://www.cdc.gov/measles/signs-symptoms/index.html>

- 17 CDC — Vaccine Ingredients (thimerosal, aluminum, formaldehyde)
<https://www.cdc.gov/vaccine-safety/about/ingredients.html>
- 18 CHOP Vaccine Education Center — vaccine ingredients and the dose-makes-the-poison principle
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- 19 Doherty Institute — measles in Samoa
<https://www.doherty.edu.au/articles/measles-in-samoa-in-the-grips-of-an-outbreak-disaster/>
- 20 Dux et al., Science (2020)
<https://www.science.org/doi/10.1126/science.aba9411>
- 21 Dux et al., Science (2020) — measles–rinderpest divergence
<https://www.science.org/doi/10.1126/science.aba9411>
- 22 ECDC — Measles Facts
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- 23 Furuse et al., Virology Journal (2010)
<https://d-nb.info/1098729005/34>
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<https://www.acpjournals.org/doi/10.7326/M18-2101>
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<https://pmc.ncbi.nlm.nih.gov/articles/PMC3136032/>
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- 28 Journal of Global Health (2020) — coverage collapse and toll
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- 29 Journal of Pacific Studies (2023)
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- 33 Lancet (2024) — deaths averted by vaccination
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- 34 The Lancet (Thornton, 2020) — outbreak and aftermath
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<https://www.latimes.com/local/obituaries/la-me-thomas-peebles-20100813-story.html>
- 37 Merck company history
<https://www.merck.com/company-overview/history/>
- 38 Mina et al., Science (2019)
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- 39 Mina et al., Science (2019) — immune amnesia
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- 43 Muslim Heritage — Al-Razi on Smallpox and Measles
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- 45 National Academies — Hilleman memoir
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<https://www.nasonline.org/wp-content/uploads/2024/06/hilleman-maurice.pdf>
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