

Pioneers of Knowledge

Master Index and Publication Standard

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Purpose

PIO is a historical and evolutionary series about how human knowledge became cumulative, externalised, measurable, testable, networked and technologically extensible. The series is organised as 92 autonomous articles that can be cited separately and also read as chapters of a single work.

Publication architecture

- PIO-000 is the master index and public publication standard for the series.
- PIO-000 to PIO-092 are 93 individual publication records, each intended to receive its own persistent identifier and DOI; each record contains one monolingual English PDF and one monolingual Spanish PDF under the same DOI.
- The scientific, general-reader, youth and children collected editions are separate publication objects. English and Spanish editions are monolingual publication files.
- Article identifiers remain stable across corrections. A corrected public file must not silently replace a countersigned object unless the publication platform permits a transparent file replacement under the same record and the correction policy is satisfied.
- Cross-references use the stable PIO identifier. The DOI of the individual article is the preferred citation target for article-level citation.

Editorial invariants

- Clean titles, with no release labels or internal editorial annotations.
- Each public article PDF is monolingual: one English file and one Spanish file belong to the same Zenodo record and share one DOI.
- Public PDF headers identify the PIO series, not another project or collection.
- Scientific text must remain traceable to the countersigned source object.
- Tables, if present in later editions, must not be split across pages unless materially unavoidable; repeated headers are required for multi-page tables.
- Empty layout gaps, orphan headings, clipped text and broken glyphs are not acceptable publication output.
- Bibliographic and dependency corrections must be explicit, reviewable and reproducible.

Canonical article index

- **PIO-001** — Cooperation and cumulative culture
- **PIO-002** — Stone tools and cumulative design
- **PIO-003** — Controlled fire, cooking and shared learning
- **PIO-004** — Language, symbols and shared abstraction
- **PIO-005** — Clothing, fibres and environmental adaptation
- **PIO-006** — Rivers, coasts and early navigation
- **PIO-007** — Indigenous landscape management and controlled burning
- **PIO-008** — Pottery, containers and controlled transformation
- **PIO-009** — Agriculture in multiple independent centres
- **PIO-010** — Animal domestication and pastoral knowledge
- **PIO-011** — Fermentation, preservation and accumulated empirical knowledge
- **PIO-012** — Wheel, axle and transport
- **PIO-013** — Copper and bronze metallurgy
- **PIO-014** — Cuneiform accounting, writing and external memory
- **PIO-015** — Weights, measures and standards
- **PIO-016** — Laws, contracts and institutional memory
- **PIO-017** — Egyptian surveying and geometry

- **PIO-018** — Babylonian mathematical astronomy and sexagesimal place value
- **PIO-019** — Calendars, seasons and agricultural risk
- **PIO-020** — African iron metallurgy and regional innovation
- **PIO-021** — Roads, logistics and organised information
- **PIO-022** — Money, accounting and trust beyond personal relationships
- **PIO-023** — Deductive proof: what Greek geometers added
- **PIO-024** — Eudoxus, Archimedes and exhaustion methods
- **PIO-025** — Aristarchus and Solar-System scale
- **PIO-026** — Eratosthenes and the size of Earth
- **PIO-027** — Hipparchus and quantitative astronomy
- **PIO-028** — Ptolemy and predictive mathematical astronomy
- **PIO-029** — Chinese paper and inexpensive external memory
- **PIO-030** — Maya zero and calendrical astronomy
- **PIO-031** — Indian zero, positional notation and astronomy
- **PIO-032** — Translation, commentary and original science in the Islamic world
- **PIO-033** — Al-Khwarizmi and algebraic procedures
- **PIO-034** — Ibn al-Haytham and experimental optics
- **PIO-035** — Al-Biruni and geodesy
- **PIO-036** — Hippocratic, Galenic, Ayurvedic and Islamic medicine: systematic clinical knowledge
- **PIO-037** — East Asian printing and knowledge multiplication
- **PIO-038** — Chinese engineering, compass and gunpowder traditions
- **PIO-039** — Polynesian and Indigenous wayfinding
- **PIO-040** — How numerals travelled: India, Baghdad and Pisa
- **PIO-041** — Medieval universities and organised disputation
- **PIO-042** — Maps, coordinates and the representation of space
- **PIO-043** — Glass, lenses and the extension of vision
- **PIO-044** — Renaissance humanism, perspective and printing
- **PIO-045** — Vesalius and anatomical observation
- **PIO-046** — Copernicus and heliocentric re-ordering
- **PIO-047** — Tycho Brahe and precision observation
- **PIO-048** — Kepler and mathematical laws of motion
- **PIO-049** — Galileo and controlled measurement
- **PIO-050** — Bacon, Descartes and explicit method
- **PIO-051** — Academies, journals and the public experiment
- **PIO-052** — Microscopy, cells and microorganisms
- **PIO-053** — Newton, mechanics and universal gravitation
- **PIO-054** — Calculus, limits and infinitesimals
- **PIO-055** — Longitude, clocks and precision time
- **PIO-056** — Probability, censuses and error: Pascal to Quetelet
- **PIO-057** — Steam engines: when technology preceded theory
- **PIO-058** — From variolation to vaccination
- **PIO-059** — Lavoisier and quantitative chemical transformation
- **PIO-060** — Geology and deep time
- **PIO-061** — Volta and reproducible electrochemical sources
- **PIO-062** — Dalton, atoms and chemical combination
- **PIO-063** — Thermodynamics and energy accounting
- **PIO-064** — Faraday and field-based physics
- **PIO-065** — Semmelweis, Snow and evidence from patterns
- **PIO-066** — Darwin, Wallace and common descent
- **PIO-067** — Maxwell and electromagnetic unification

- **PIO-068** — Mendel and statistical regularity in heredity
- **PIO-069** — Pasteur, Lister and Koch: from antiseptic intervention to germ proof
- **PIO-070** — Photography and spectroscopy: instruments that remember light
- **PIO-071** — Mendeleev and periodic organisation
- **PIO-072** — Telegraph and radio: knowledge travelling faster than people
- **PIO-073** — Public literacy, newspapers and scientific debate
- **PIO-074** — Electrical networks and technological systems
- **PIO-075** — X-rays, radioactivity and the measurable atom
- **PIO-076** — Einstein and spacetime
- **PIO-077** — Wegener and continental drift
- **PIO-078** — Leavitt, Slipher, Lemaître and Hubble: the expanding universe
- **PIO-079** — Noether, symmetry and conservation
- **PIO-080** — Quantum mechanics and the limits of classical description
- **PIO-081** — Antibiotics and experimental control of infection
- **PIO-082** — Turing and programmable computation
- **PIO-083** — Nuclear physics, nuclear energy and dual-use knowledge
- **PIO-084** — Shannon and measurable information
- **PIO-085** — Randomised trials and statistical inference
- **PIO-086** — Research ethics, consent and the limits of permissible inquiry
- **PIO-087** — DNA and molecular heredity
- **PIO-088** — Satellites and the planetary point of view
- **PIO-089** — Plate tectonics: mechanism, synthesis and converging evidence
- **PIO-090** — Networks, simulation and machine learning
- **PIO-091** — Climate science and knowledge of a coupled planet
- **PIO-092** — Modern detectors and the invisible universe

Citation model

For an individual article, cite the author, article title, PIO identifier, year, individual DOI and the series title. DOI values are assigned at publication and are therefore not embedded in this pre-publication master index.

Correction policy

Corrections must preserve the audit trail between source, public PDF and published record. Scientific changes create a new reviewed object. Purely editorial changes may retain the scientific source version only when the changed publication bytes are separately reviewed and countersigned. No correction may be introduced silently into an already countersigned byte object.