Shō-coin: A knowledge-based economy for Life Sciences
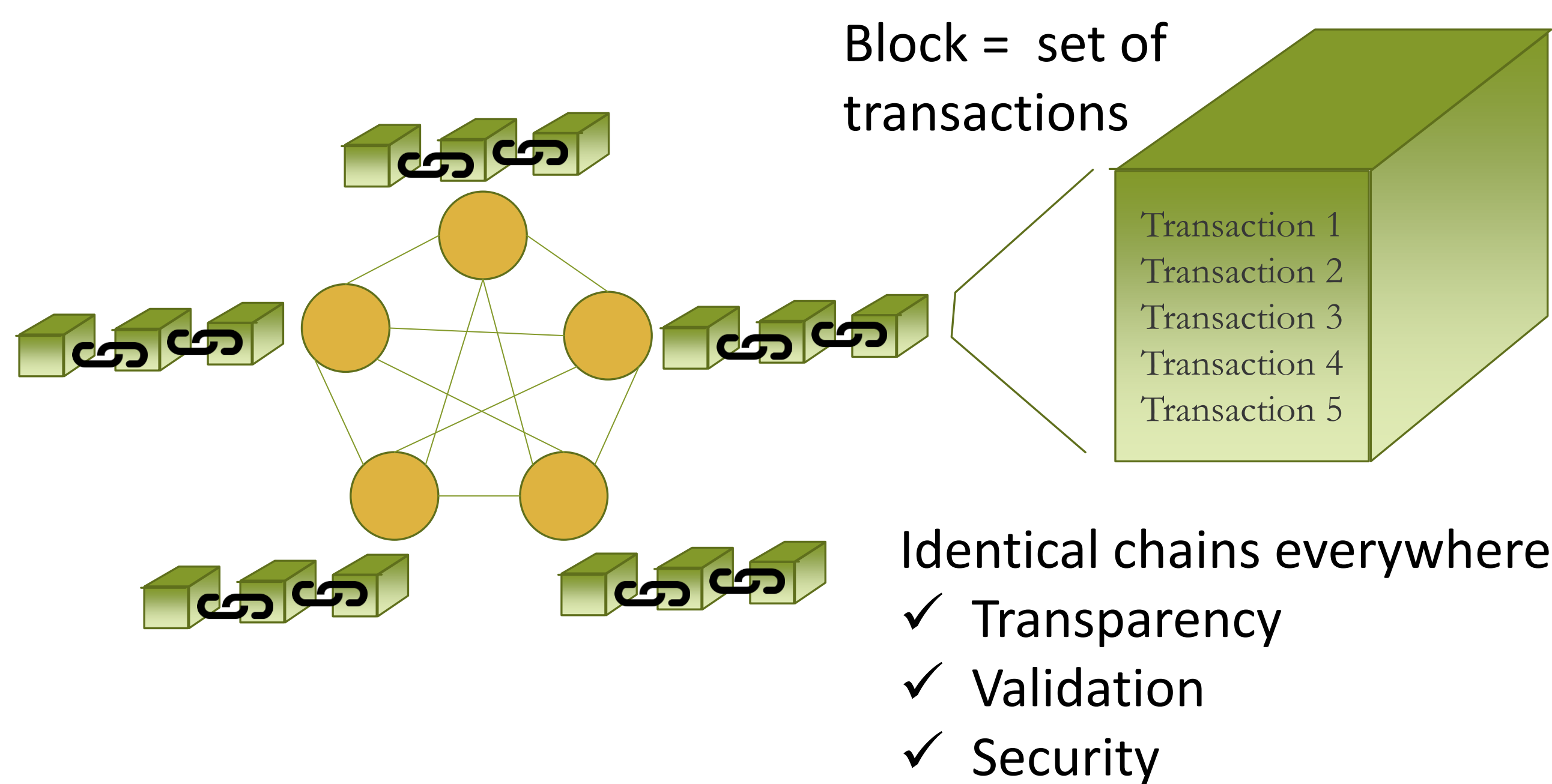
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[1] Norwegian University of Science and Technology, [2] Universidad Politécnica de Madrid, [3] Universitat Jaume I, [4] University Medical Center Utrecht, [5] Naturalis Biodiversity Center
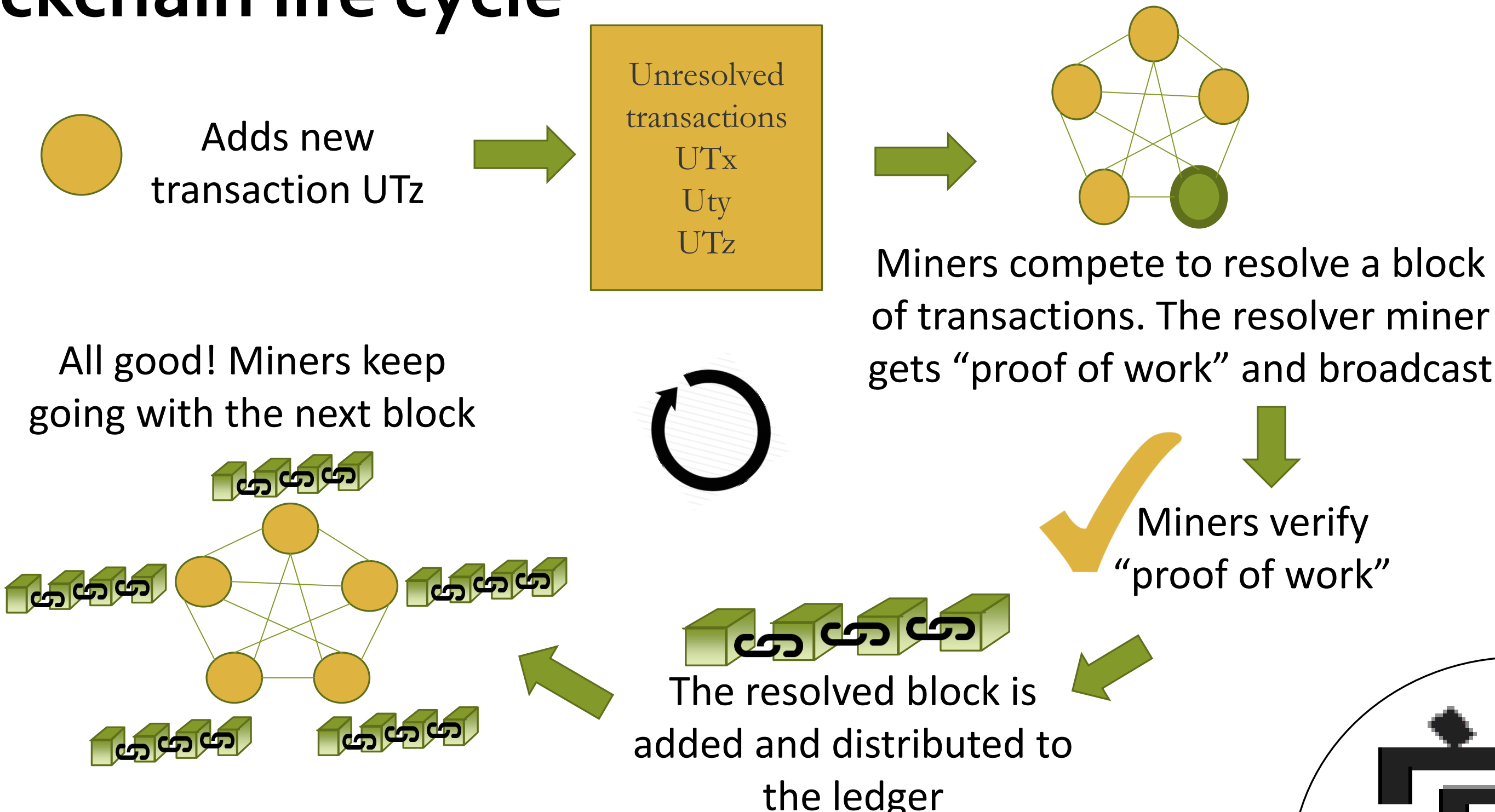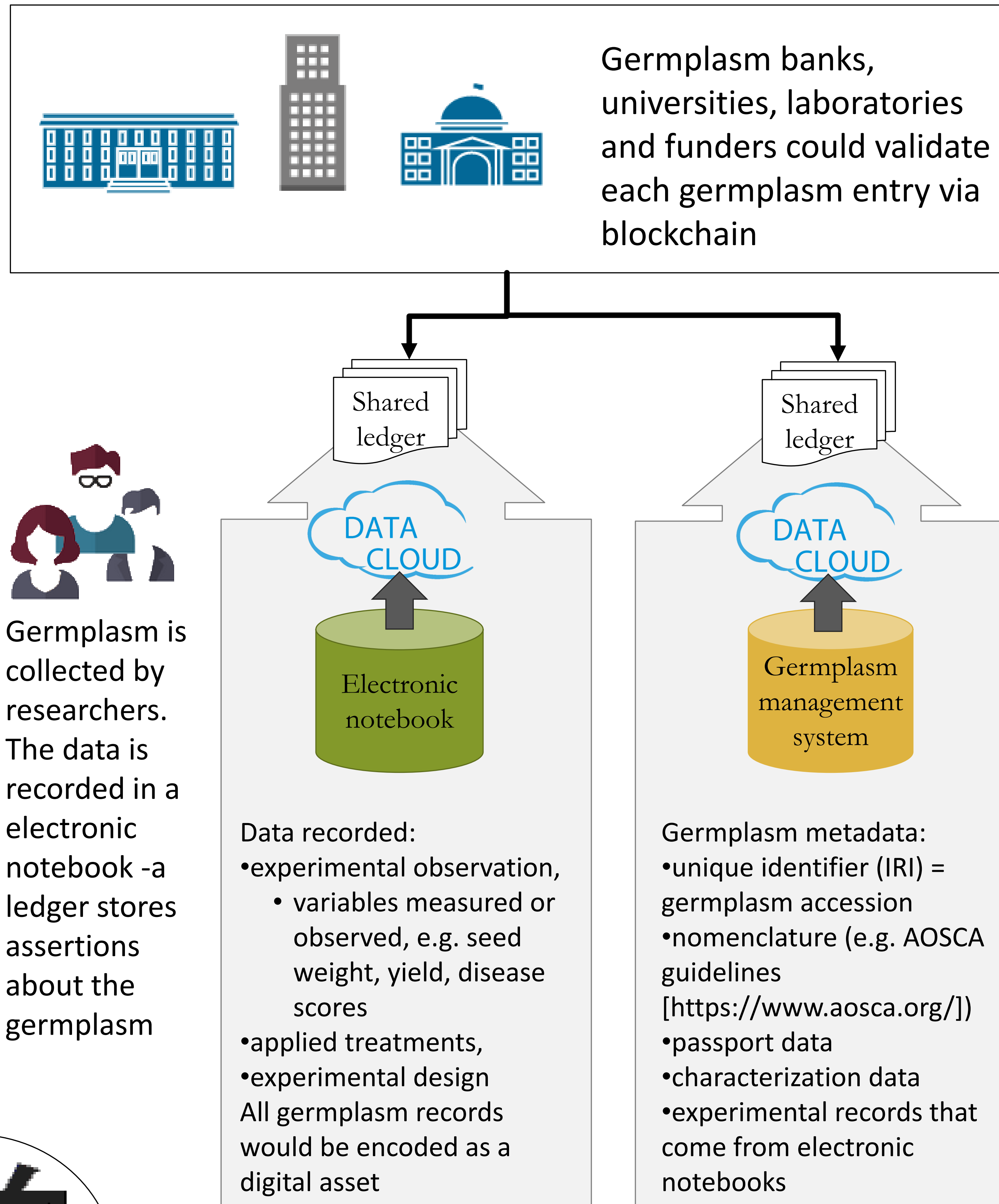
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What is a blockchain?

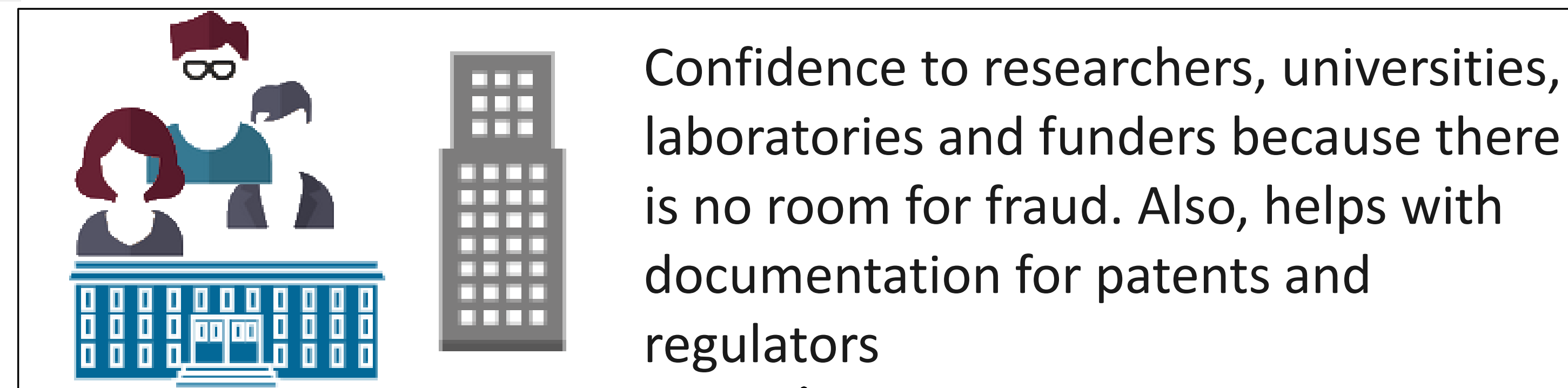**Blockchain:** / blɒk-tʃeɪn /
Immutable distributed ledger

Block = set of transactions

Transaction 1
Transaction 2
Transaction 3
Transaction 4
Transaction 5

Identical chains everywhere
✓ Transparency
✓ Validation
✓ Security

Blockchain life cycle

Adds new transaction UTz

Unresolved transactions
UTx
Uty
UTz

Miners compete to resolve a block of transactions. The resolver miner gets "proof of work" and broadcast

All good! Miners keep going with the next block

Miners verify "proof of work"

The resolved block is added and distributed to the ledger

Germplasm banks use case

Germplasm banks, universities, laboratories and funders could validate each germplasm entry via blockchain

Shared ledger

Shared ledger

DATA CLOUD

DATA CLOUD

Electronic notebook

Germplasm management system

Germplasm is collected by researchers. The data is recorded in a electronic notebook -a ledger stores assertions about the germplasm

Data recorded:
• experimental observation,
  • variables measured or observed, e.g. seed weight, yield, disease scores
• applied treatments,
• experimental design
All germplasm records would be encoded as a digital asset

Germplasm metadata:
• unique identifier (IRI) = germplasm accession
• nomenclature (e.g. AOSCA guidelines [https://www.aosca.org/])
• passport data
• characterization data
• experimental records that come from electronic notebooks

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Experimental record use case

Confidence to researchers, universities, laboratories and funders because there is no room for fraud. Also, helps with documentation for patents and regulators

Shared ledger
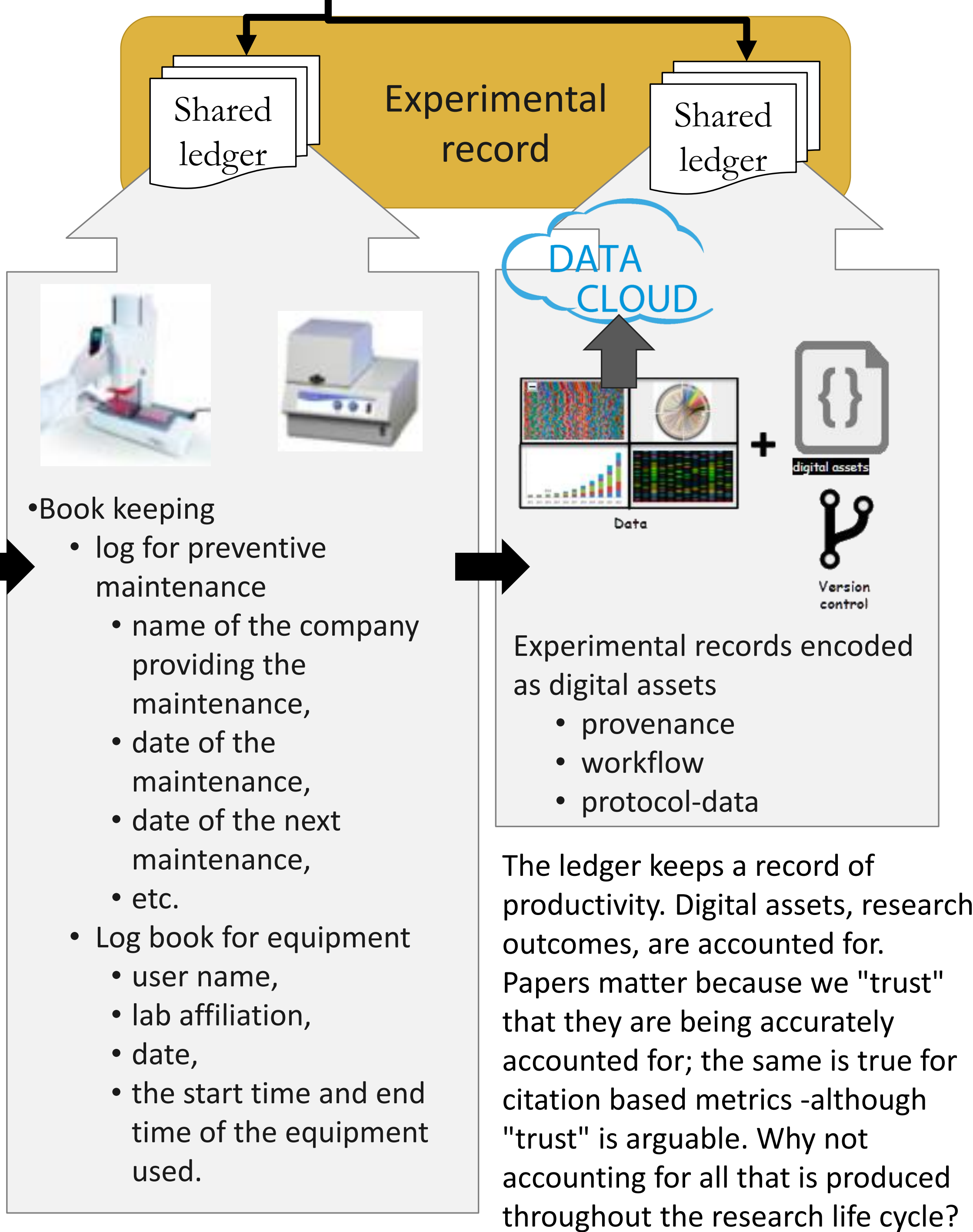
Experimental record

Shared ledger

DATA CLOUD

Data

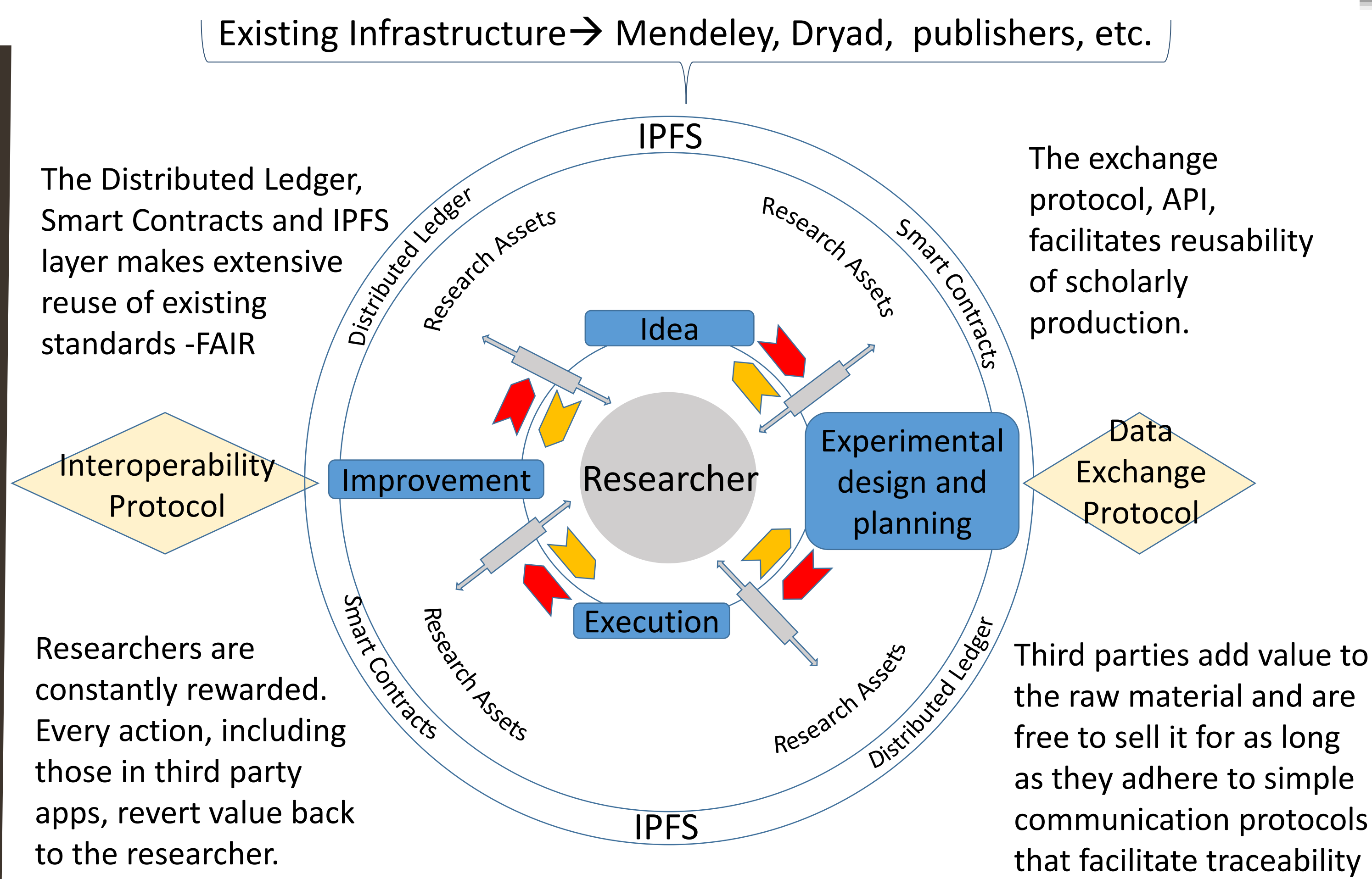digital assets

Version control

Experimental records are produced by
• Researchers using high throughput methods
• less tech dependent measures and observations.

Protocols → workflow with associated data

• Book keeping
  • log for preventive maintenance
    • name of the company providing the maintenance,
    • date of the maintenance,
    • date of the next maintenance,
    • etc.
  • Log book for equipment
    • user name,
    • lab affiliation,
    • date,
    • the start time and end time of the equipment used.

Experimental records encoded as digital assets
  • provenance
  • workflow
  • protocol-data

The ledger keeps a record of productivity. Digital assets, research outcomes, are accounted for. Papers matter because we "trust" that they are being accurately accounted for; the same is true for citation based metrics -although "trust" is arguable. Why not accounting for all that is produced throughout the research life cycle?

Award model

Existing Infrastructure → Mendeley, Dryad, publishers, etc.

IPFS

The Distributed Ledger, Smart Contracts and IPFS layer makes extensive reuse of existing standards -FAIR

The exchange protocol, API, facilitates reusability of scholarly production.

Distributed Ledger
Research Assets
Smart Contracts
Research Assets

Idea
Improvement
Researcher
Experimental design and planning
Execution

Interoperability Protocol

Data Exchange Protocol

Smart Contracts
Research Assets
Distributed Ledger

IPFS

Researchers are constantly rewarded. Every action, including those in third party apps, revert value back to the researcher.

Third parties add value to the raw material and are free to sell it for as long as they adhere to simple communication protocols that facilitate traceability

Research assets are managed by distributed ledgers integrated into institutional repositories. Smart contracts implement policies defined by institutions, funders and/or communities. The research lifecycle is managed by universities and institutes; value is added by third parties adhering to communication protocols, thus reusing and repurposing what has been produced. Research assets are thus accounted for and therefore revert value back to the researcher at every step of the research lifecycle. Our approach ensures transparency and enforces trust.

Ideas, questions, comments, suggestions? **Stick it!** Help us build a blockchain for Life Sciences ☺

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