How life constructs itself

Life constructs itself using few simple rules of information processing.

On the one hand, there is a set of rules determining how such basic chemical reactions as transcription, translation, and catalysis proceed.

On the other hand, there is a set of rules determining how these basic chemical reactions couple forming the information processing networks of growing complexity.

Constructing itself, life arranges basic chemical reactions –

transcription,
translation,
and catalysis

– in strong hierarchy of life patterns:

Level	Life pattern…	… is roughly equal to
4	Genome diversification network	General cell progression (living world or biosphere)
3	Genome multiplication network	Individual cell progression
2	Genome expression network	Cell
1	Gene expression network	

This hierarchy

captures the immense complexity of the living world.

While

the genome diversification network (general cell progression) is most likely unique,

three other life patterns are enormously variable.

Their innumerable variations underlie the life diversity.

Transcription,

Translation

Catalysis

Transcription,

Translation

Catalysis

During transcription,

one strand of DNA molecule separates from another and

exposes a particular sequence of deoxyribonucleotides – gene – serving as a template by guiding the synthesis of RNA molecule.

This is possible

because a ribonucleotide is allowed to be attached to the deoxyribonucleotide according to strict rules of base pairing:

Deoxyribonukleotide with the base…	Adenin	Cytosin	Guanin	Thymin
… attaches ribonukleotide with the base	Uracil	Guanin	Cytosin	Adenin

So,

the sequence of deoxyribonucleotides within a gene determines the sequence of ribonucleotides within RNA molecule to be synthesized.

Accordingly,

a complementary RNA replica appears on the DNA template and then separates from it.

Note: the DNA molecule persists transcription and remains unexhausted.

Transcription,

Translation

Catalysis

During translation,

the RNA molecule serves as a template for the synthesis of a polypeptide molecule.

In this process,

the triplets of ribonucleotides in RNA molecule – codons – determine amino acids to be attached to the polypeptide:

Codons..	for amino acid
GCA, GCC, GCG, GCU	Alanin (Ala, A)
UGC, UGU	Cystein (Cys, C)
GAC, GAU	Asparaginsäure (Asp, D)
GAA, GAG	Glutaminsäure (Glu, E)
UUC, UUU	Phenylalanin (Phe, F)
GGA, GGC, GGG, GGU	Glycin (Gly, G)
CAC, CAU	Histidin (His, H)
AUA, AUC, AUU	Isoleucin (Ile, I)
AAA, AAG	Lysin (Lys, K)
CUA, CUC, CUG, CUU, UUA, UUG	Leucin (Leu, L)
AUG	Methionin (Met, M)
AAC, AAU	Asparagin (Asn, N)
CCA, CCC, CCG, CCU	Prolin (Pro, P)
CAA, CAG	Glutamin (Gln, Q)
AGA, AGG, CGA, CGC, CGG, CGU	Arginin (Arg, R)
AGC, AGU, UCA, UCC, UCG, UCU	Serin (Ser, S)
ACA, ACC, ACG, ACU	Threonin (Thr, T)
GUA, GUC, GUG, GUU	Valin (Val, V)
UGG	Tryptophan (Trp, W)
UAC, UAU	Tyrosin (Tyr, Y)

So,

> the sequence of codons within RNA molecule determines the sequence of amino acids within polypeptide molecule to be synthesized.

Accordingly,

> a complementary polypeptide replica appears on the RNA template.

Note: the RNA molecule persists translation without to be exhausted.

Transcription,

Translation

Catalysis

During catalysis, the catalyst

serves as a template for the reaction that otherwise could occur too slowly for live,

does its job of catalysis by grappling with one or more substrate molecules and interacting with them to make or break chemical bonds,

is usually very specific for the chemical reaction it catalyses.

The specificity

lies in a sophisticated configuration of atoms at one or more active sites of catalyst.

Only restricted set of substrate molecules

can recognize this configuration and

bind it.

In catalysts,

this binding causes a conformational shift that promotes the reaction in any way.

Thereafter,

the catalyst releases reaction products, acquires its original conformation and is available for catalysis anew.

Note: the catalyst persists catalysis without to be exhausted.

In living world,

virtually all reactions are to be catalysed,

inclusive all reactions of polymerization.

The most important reaction of polymerization is

DNA replication.

During DNA replication,

strands of DNA molecule separate and

each strand serves as a template by guiding the synthesis of complementary strand according to strict rules of base pairing:

Deoxyribonukleotide with the base…	Adenin	Cytosin	Guanin	Thymin
… attaches deoxyribonukleotide with the base	Thymin	Guanin	Cytosin	Adenin

When the DNA replication is complete,

each original DNA molecule is replaced by its two identical copies.

Note: the DNA molecule strands persist replication without to be exhausted.

Gene expression network

Genome expression network

Genome multiplication network

Genome diversification network

Gene expression network

Genome expression network

Genome multiplication network

Genome diversification network

The sequence

DNA transcription -> RNA translation -> catalysis

builds

the most fundamental unit of information processing in the living world.

This life pattern can be called

the gene expression network (abbreviated GEN).

In some GENs, however, this sequence can be restricted.

So, in any GENs,

> the end products are polypeptides functioning always as substrate molecules and never as catalysts.

There are also GENs

> which end products are RNAs that never become translated into polypeptides, but function always at the level of RNA as substrate molecules.

On the other hand, the sequence of reactions in some GENs extends if the products of

transcription or

translation

undergo

post-transcriptional or

post-translational processing

respectively.

Gene expression network

Genome expression network

Genome multiplication network

Genome diversification network

Usually,

the genes are associated in a limited set – a genome.

Respectively,

the GENs are organised in more complicated unit of information processing in the living world.

This life pattern can be called

the genome expression network (abbreviated GENom).

This life pattern is roughly equal to the cell.

In the cell,

> the genome expression is tightly coupled to the genome replication.

Respectively,

> the life history of the single cell begins with one cell but ends with two.

Generally, the cell life history begins at the point where

two newly produced sister cells halve the matrix inherited from the mother cell and

each starts a self-dependent life.

What the newborn cell has to do is just what its mother done:

it starts its own genome expression

which results in genome replication and in division in two daughter cells.

Gene expression network

Genome expression network

Genome multiplication network

Genome diversification network

Progressive genome replication by genome expression leads

to much more complicated unit of information processing in the living world.

This life pattern can be called

the genome multiplication network.

Progressive genome replication is usually associated with progressive cell propagation producing a cell progression:

one cell ->
two cells ->
four cells ->
eight cells ->
and so on…

The entire living world is

the only one cell progression which arose from one single primordial cell.

However,

the genome multiplication is tightly associated with genome diversification.

The mechanisms of genome diversification differ greatly ranging

from the spontaneous sequence mutation

to the highly regulated sequence transfer.

The genome diversification produces

cell progressions each of which is specified by a particular individual genome and can be called individual cell progression.

Respectively,

the entire living world can be considered as a growing composition of an increasing number of individual cell progressions.

Gene expression network

Genome expression network

Genome multiplication network

Genome diversification network

The entire living world is the only one cell progression which

arose from one single primordial cell and

has 3 or 4 billions years of uninterrupted history.

It represents the most complicated unit of information processing in the living world.

This life pattern can be called

the genome diversification network or
the general cell progression.

The present-day biosphere is merely

a tiny slice from it, a visible top of iceberg in ocean of time.

The ancient part of this gigantic life pattern leaves

very scarce traces