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Physical world macromolecules and cell life

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Preface

This is a narration of *Biochemistry*, *Biophysics*, *Cell* and *Molecular Biology* from the viewpoint of basic research, enhanced by the enthusiasm and the passion of a generation that took up the greatest challenges of the 20th century, from extraterrestrial exploration to mapping the human genome. A generation fueled by insatiable curiosity and engaged in seeking answers to intriguing questions, like the basic grammar rules of *cell differentiation*, *cancer de–differentiation* or *brain memory codification*.

Starting from an experimental insight on *pacemaker evolution*, of interest in *Space Biology*, and a theoretical reasoning on *brain language*, fascinating in both *Cybernetics* and *Neurobiology*, a novel method to measure the lengths of the *cell cycle* and its *phases* in *synchronized suspensions* was divised. A laboratory journey through the biosynthesis of *DNA, RNA, proteins* and their *amino acidic* and *nitrogen base precursors*, during the whole *interphase* and *karyokinesis*, was accomplished. A crucial study on cell–cycle dependent *maintenance* and *de novo DNA methylation*, leading to *Epigenetics* as a science for control of *gene expression* and *organ–formation*, was made revealing an involvement of *post–synthetic DNA modification* in *regulation of transcription*. The discovery of *rare nucleotides* in ox brain and the finding of unexpected alternate *coding* (*exon*) and *non–coding* (*intron*) *fragments* along the *eukaryotic genes* paved the way to the nascent *Genetic Engineering* in higher cells. An investigation into the differentiation of *enzymatic chains* and *metabolic pathways* in normal and tumor tissues was undertaken concentrating on the *regulation of gene expression* as a function of the *Ontogeny*. A study on the *evolution* of the *genetic code* and a comparative analysis of *glia–*

neuron and *virus–cell* interactions were performed, focusing on *electron spin resonance* of growing *normal* and *virus–transformed* cultures. Last but not least, a research on *extraretinic pigmentation* and *color discrimination* in flies**,** and the interaction of *living matter* with *ionizing* and *non–ionizing radiations*, especially *light* and *magnetic field*, was successfully carried out.

The narrative keeps the problematic–historic character of my lessons: *Biological Chemistry* (taught for twenty years at the Faculties of Mathematical Physical and Natural Sciences of the University of Naples Federico II and of the University of Catania); *Biophysics*, *Radiobiology*, *Biochemistry* and *Biophysics*, *Biochemical Engineering* and *Physical World Macromolecules and Life* (taught for other nearly two decades at the Faculty of Mathematical Physical and Natural Sciences of the University of Rome Tor Vergata); *Molecular Biology* (taught for seven years — in parallel with my teaching in Rome — at the Faculty of Mathematical Physical and Natural Sciences of the Polytechnic University of Marche in Ancona). The title of this book was suggested by the course I taught in Rome, *Physical World Macromolecules and Life*. The topics covered in it should make an interesting reading for biologists, physicians, chemists, physicists and all those who work in the *bioengineering* and *bioecological* fields. The readers dealing with experimental and theoretical problems, oriented on investigating and protecting the biosphere (which is more and more exposed to various kinds of pollutants due to artificial *ionizing* and *non–ionizing* radiations), might find some logic for thought here, too.

The volume is organized in ten chapters, divided into forty paragraphs, each subdivided into a number of subparagraphs. The main body of the text is enriched with 183 figures and captions describing in detail the methodological and experimental procedures applied. A number of pictures portray our own and our colleagues' life in laboratories around the world. The *references* for the relevant papers on different topics are evidenced in italics and in square brackets, while the *source* of our results and the corresponding *consensus* by others in the international scientific community are listed at the end of each chapter.

The account was written hoping that elsewhere the state of the art of the various topics launched by our experimental work, lasting more than half century, inevitably would advance stepwise. Whatever new

data and information will surface in the future, whatever new methodological criteria will be considered and developed, the really important thing is the search for truth. The truth, particularly when recognized by other scientists decade after decade, retains its own persuasiveness regardless of time, lab or place.

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Abbreviations

Adenine (A),
Alanine (Ala),
Albert Einstein College of Medicine (AECM),
Alternate current (AC),
Anti–Shine–Dalgarno (anti–SD),
Arginine (Arg),
Asparagine (Asn),
Aspartic acid (Asp),
Bromodeoxyuridine (BrdUrd),
Calcitonin (CALC),
Carcinoma of human cervix (HeLa),
Counts per minute (cpm),
Culture growth cycle (CGC),
Cysteine (Cys),
Cytosine (C),
[^{14}C]methyl–L–methionine ([^{14}C]Met),
Deoxyadenylate methylase (dam),
Deoxycytidylate methylase (dcm),
Deoxyribonucleic acid (DNA),
2–dimethylamino–6–lauroylnaphthalene (LAURDAN),
Dimethylsulfoxide (DMSO),
Disintegration per minute (dpm),
DNA methyltransferase or *methylase* (DNAmet),
DNA polymerase (DNApol),
Direct current (DC),

Extremely low frequency magnetic field (ELF MF),
Estrogen receptor (ER),
Ethylenediamine tetra–acetic acid (EDTA),
European Atomic Energy Community (EURATOM),
Flavin adenine dinucleotide (FAD),
Fluorodeoxyuridine (FdUrd),
Foetal calf serum (FCS),
X–fragile (FMR–1),
Friend erythroleukemia (FL),
Friend leukemia virus (FLC),
Geomagnetic field (GMF),
Generalized polarization (GP),
Glutamic acid (Glu),
Glutamine (Gln),
Glycine (Gly),
Guanine (G),
Hemoglobin (Hb),
Hydroxyurea (HU),
High performance liquid chromatography (HPLC),
Histidine (His),
Housekeeping (HK),
Human macrophage (UM),
Human tissue transglutaminase (hTGc),
Human umbilical vein endothelial cells (HUVEC),
Initiation factor (IF),
Institute of Experimental Medicine (IMS),
International Institute of Genetics and Biophysics (IIGB),
Isoleucine (Ile),
Leucine (Leu),
Long terminal repeat (LTR),
Lysine (Lys),
Magnetic field (MF),
Magnetically shielded room (MSR),
Melting point (T_m),
Messenger RNA (mRNA),
Methionine (Met),
N^6–Methyl–adenine (m^6A),

Methyl–S–adenosyl–L–methionine (AdoMet),
5–Methylcytosine (m^5C),
[^{14}C]Methyl–L–methionine ([^{14}C]Met),
Methyltransferase (met),
Minimum essential medium (MEM),
Minus strand poliovirus RNA ($vRNA^-$),
Mitochondrial DNA (mtDNA),
Monocyte–derived macrophage (MDM),
Mycobacterium tuberculosis (MTB),
National Institute of Health (NIH),
National Nuclear Energy Committee (CNEN),
National Research Council (CNR),
N–ethylmaleimide (MalNEt),
Nuclear DNA (nDNA),
5′–[^{32}P]octamer ([^{32}P]oct),
Ornithine decarboxylase (ODC),
Ornithine–δ–transaminase (OTA),
Phenylalanine (Phe),
Plus strand poliovirus RNA ($vRNA^+$),
PolyA–containing pre–messenger RNA [pre–mRNA(polyA)],
Polymer chain reaction (PCR),
Pre–processed messenger RNA (pre–mRNA),
Pre–processed ribosomal RNA (pre–rRNA),
Pre–processed transfer RNA (pre–tRNA),
Proline (Pro),
Puromycin (PMC),
Real–time polymerase chain reaction (RT–PCR),
Repair patch (RP),
Restriction–modification (RM),
Reverse transcriptase (RT),
Ribonucleic acid (RNA),
Ribosomal DNA (rDNA),
Ribosomal RNA (rRNA),
Ribosomal subunit (RSU),
RNA polymerase or *transcriptase* (RNApol),
Serine (Ser),
Shine–Dalgarno (SD),

Simian virus 40 (SV40),
Sodium dodecyl sulfate (SDS),
Solenoid (SLD),
Tesla (T),
Threonine (Thr),
Thymine (T),
Tissuespecific (TS),
Transfer RNA (tRNA),
Trichloroacetic acid (TCA),
Trifluoroacetic acid (TFA),
Tryptophan (Trp),
Tyrosine (Tyr),
α–Tyrosine (αTyr),
United Nations Educational Scientific and Cultural Organization (UNESCO),
Untranslated region (5'–UTR),
Uracil (U),
Valine (Val).