Chapter 1
Bio-Medicolegal Sciences and Personal Injury/Damage Ascertainment in the Post-Genomic Era

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Abstract The first part of the chapter analyzes the techno-scientific evolution of postmodern biomedicine, highlighting the pros and cons of the holistic approach of systems biology and its clinical translation in the form of individualized precision medicine, as well as the opportunity to refound the doctor–patient relationship and the healthcare organization of the third millennium on the principles of personalized slow and value medicine. In the second part, the historical development of the bio-medicolegal sciences, their progressive disintegration into specialized subdisciplines, and the related need to find a biomolecular unitariness are discussed. The chapter then deals with the problems and the current limits of personal injury and damage ascertainment, envisaging an increase in the objectivity and accuracy of the impairment and disability assessment through the medicolegal implementation of technology platforms of in vivo functional imaging and bio-analysis, developed by postmodern biomedicine. The conclusions stress the importance of investing in human capital, through teaching and education at a university level. The main responsibility of academic institutions, indeed, is to educate toward a critical mentality and a democratic citizenship of the world, safeguarding the transmission of knowledge of the past together with the defense of the idea that it is feasible to innovate such knowledge.

1.1 Introduction

Post-genomic biomedicine, also referred to as P4 Medicine, being personalized, predictive, preventive, and participative, has surpassed the traditional approach to diagnosis and treatment, in a patient-centric vision, where, thanks to new omics

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technologies (genomics, epigenomics, proteomics, metabolomics, fragmentomics, and interactomics), it is possible to analyze and evaluate the individual biomolecular profile of the subject. This profile, providing a significant contribution to the diagnosis and the specific choice of treatment, will permit, in the near future, the minimization of a given treatment's toxicity, improve the quality of life of patients, and optimize the management of healthcare resources.

A paradigmatic example of the extraordinary potential of translational omics is the *integrative personal omics profile* (iPOP) [1], which involves a combined analysis of genomic, transcriptomic, proteomic, metabolomic, and autoantibody profiles from a single individual over a 14-month period [1].

Of the same innovative reach is the application of the "geographic information system" (GIS) [2] for mapping, in biomolecular terms and in a sort of "pre-womb to tomb assessment," the various moments in the life of a patient, from preconception to the fetal, neonatal, childhood, and adult periods [2].

Equally interesting is the recent application of micro- and nanotechnology to "single cell and spatially resolved omic analysis" that aims to collect genotranscripto-proteomic data retaining positional information [3].

The advent of laser capture microdissection, permitting the isolation of a group of cells from a given tissue and the subsequent extraction of DNA and RNA and the development of a "mass cytometry," capable of identifying and quantifying protein at the subcellular level, will soon make it possible to reveal, through a high-dimensional data analysis, new spatiotemporal interdependencies disclosing the molecular pathways and biological interconnections of the entire biological system of the "person."

The enormous translational potentialities originating from the extraordinary progress of technological imaging and bioanalytical platforms will require intensive and rigorous validation efforts in order to determine whether individualized precision medicine is really able to improve, in a cost-effective manner, the clinical–diagnostic course and the patient outcome [3]. The extreme technologicalization of personalized medicine and the increasing reliance on algorithms and artificial intelligence will continue to change the face of postmodern biomedicine and to transfigure the therapeutic relationship [4], directing it toward "personalized slow and value medicine," in a neo-humanistic vision of the profession.

In such a framework the bio-medicolegal sciences have been experiencing, for some time now, a deep crisis of cultural and scientific impoverishment, dependent upon a variety of phenomena and factors, the leading among them being the progressive fragmentation of knowledge with the emergence of mutually independent and isolated specialist subdisciplines, the paucity of funds for international and national research, and the lack of an inter- and transdisciplinary vision, ready to assimilate and develop the technical, technological, and epistemological innovations of post-genomic biomedicine.

Some recent bibliometric studies [5–7] have highlighted a good level of publication in terms of the number of contributions and citation indices (e.g., impact factor, citation index, h-index) for specialized subdisciplines such as forensic genetics, anthropology, toxicology, and radiology, with some papers on the subject

of virtopsy, personal identification, postmortem interval estimation, child sexual abuse, and wound age estimation downloaded and cited numerous times. There is a demonstration that the bio-medicolegal sciences have grasped the importance of publishing in "peer review" in journals with impact factor, surveyed by the most important international databases, such as *Scopus*, the *Journal Citation Report* of *ISI-Web of Science*, and *MEDLINE*.

From the studies carried out, however, a lack of innovation and interdisciplinary innovation has also emerged, demonstrated by the absence, in the international medicolegal literature, of inter- and transdisciplinary studies with the involvement of the basic sciences and the association of the forensic experts of various sub-disciplines, such as criminology, pathology, toxicology, and/or genetics [5–7].

In the race toward the future, biomedicine is moving at a rapid pace, like a rocket, whereas the bio-medicolegal sciences are proceeding with the speed of a hot-air balloon. Several black holes of knowledge still remain, regarding state and trait markers of disease, the reconstruction of molecular mechanisms of trauma, the dating of skin lesions, the evaluation of biological age, the hereditary and environmental factors linked to criminogenesis, etc.

To remedy and to guarantee their own survival, the bio-medicolegal sciences must trigger a cultural renewal that, taking account of the *holistic omic approach* and the *personalized value of medicine*, derives from an innovative systematic and from a new inter- and transdisciplinary unitariness based on *molecular evidence*.

This means not only importing the ethical and epistemological paradigms of omic holism and personalized value medicine into bio-medicolegal culture but also taking advantage of the main technological, bioanalytical, and biomedical imaging platforms developed for forensic applications, aimed at the measurement of the uncertainty of the acquired data and, in relation to scientific evidence, improving the quality of the system [8], through the implementation of proficiency testing programs and quality systems aimed at measuring the objectivity, robustness, and reliability of the data collected, the ascertainment methods, and the criteria of evaluation in bio-medicolegal sciences where they have not yet been developed, such as "clinical forensic–legal medicine," criminology, forensic psychiatry, and forensic pathology.

The ascertainment and evaluation of personal injury and damage under civil/tort law, a paradigmatic example of clinical and medicolegal assessment in which the measure of accuracy, precision, and robustness and the reliability of the epicritical assessment, in terms of scientific evidence, are still in its infancy, can profitably benefit from the translation of the new bioanalytical and molecular imaging technologies.

The overview set out in the following paragraphs illustrates these technologies, some of which have extraordinary potential for innovation and application in the bio-medicolegal evaluation of impairment and disability causally related to disorders that are currently difficult or impossible to objectify.

1.2 "Omics" Technologies

In the document of the European Commission entitled *Use of omics technologies in the development of personalized medicine* (2013), the developments of biomedical research permit the reevaluation of the role of diagnostics in the personalized approach to diagnosis, the determination of the prognosis, and the care of the patient affected by neoplastic, chronic inflammatory, and/or degenerative diseases. The availability of omics platforms (genomics, epigenomics, proteomics, miromics, metabolomics, etc.) therefore necessitates a process of qualification and validation of new biomarkers for their efficient and effective utilization within clinical practice and, in the future, in clinical forensic medicine. The amount of data obtained with these high-throughput platforms requires the integration, analysis, and development of methodologies and statistical algorithms suitable for the utilization of the obtained information in both the clinical and forensic environments.

The current state of the art implies the molecular characterization at the level of the tissues and/or recourse to "liquid biopsy," translatable into the possibility to identify the entirety of the molecular alterations which characterize a specific illness in biological fluids and, therefore, in a noninvasive and repeatable fashion.

The liquid biopsy involves the search, in relation to the blood or other biological fluids (e.g., urine, feces, cerebrospinal fluid), for (1) cells; (2) DNA; (3) mRNA and microRNA; (4) proteins, peptides, and protein profiles associated with a specific disease; and (5) alterations of metabolites and metabolic profiles.

The liquid biopsy requires, first of all, the acquisition and evaluation of technologies, which permit the analysis of single biotic components.

(1) Circulating Cells

The search for circulating cells can be carried out through various methodological approaches. The search for one or more specific transcript can be carried out on enriched (or non-enriched) samples of pathological cells (e.g., magnetic beads) permitting the identification of 1^{-10} cells per mL of whole blood. The quantification of disease-specific transcripts (qRT-PCR) allows the enhancement of the RT-PCR sensitivity. Besides these indirect methodologies of identification, new methodologies of analysis are currently available. These include immune-cytometric analysis of enriched samples, analysis with flow cytometry, as well as analysis through semiautomatic instrumentation, which includes an initial phase of enrichment via magnetic beads, followed by marking with specific antibodies for the pathological cells and any contaminating cells.

(2) DNA

The search for specific mutations in relation to neoplastic and/or degenerative illnesses through the analysis of circulating DNA is based on the premise that fragments of DNA are normally released by the cells following apoptosis. Freely circulating DNA is detectable in the plasma of subjects and is enriched in a variable percentage of DNA of tumoral origin in the event of neoplasia. The

analysis of somatic mutations important for the prognosis and/or the choice of treatment (e.g., K-ras, BRAF V600, EGFR mutations, etc.), through the analysis of plasma DNA, is one of the most innovative frontiers of translational medicine and a representative example of what is meant by liquid biopsy. Until now this approach has not gained wide diffusion due to the sensitivity limits of the available technologies. The new technologies of analysis (e.g., digital PCR) permit the detection and quantification of up to 1 % of mutated DNA, also in the event of a minimum quantity of circulating DNA. The availability of such technologies could guarantee the rapid transfer of this form of liquid biopsy into clinical practice.

(3) mRNA and Circulating MicroRNA

The genetic and phenotypic alterations of pathological cells involve, in cascade, a complex of variations in a pattern of gene transcription (transcriptome) that affect not only the messenger RNAs but also microRNAs. Traces in the biological fluids of the alterations to the abnormal cells can be detected through analysis of specific expression profiles of messenger RNA (mRNA) and microRNA. These nucleic acids are carried in the blood by means of microvesicles with a diameter of 60–120 nm, also known as exosomes. The analysis of gene expression profiles on plasma samples enriched by exosomes is an important frontier for clinical development and for a future forensic "liquid biopsy." This innovative approach of recent introduction and development requires the operational steps of fine-tuning and validation. The verification of the specific enrichment of exosomes, carried out via ultracentrifugation or by means of precipitation and centrifugation systems, can make use of imaging instrumentations (e.g., NanoSight). The profiling of gene expression can be subsequently effected via instrumentation of microarray analysis followed by validation with RT-PCR.

(4) Proteins, Peptides, and Proteomics

Analogously to that described in paragraph (3), functional alterations in gene expression can lead to cascade/feedback variations in total proteome detectable in biological fluids or parts of these. In particular, similarly to that reported for RNA and microRNA, microvesicles can carry proteins of direct pathological derivation, representing, also in this case, a potential matrix for the identification of protein biomarkers. In the context of the protein alterations induced by specific diseases, variations in the type and degree of phosphorylation of proteins (phospho-proteomics) are another potential area for translational research. The study of phosphoproteins contained in the microvesicles offers the advantage, compared to the study of freely circulating proteins, of obtaining results that are more representative of the specific neoplastic and/or degenerative illness. The search for new protein biomarkers and phosphoproteins (free or conveyed by microvesicles) in the biological fluids can make use of mass spectrometry technologies, the productive characteristics of which must guarantee the possibility to identify the largest possible number of biomarkers in the unit of time (fast-scan high resolution, such as LTQ Orbitrap). The subsequent validation of the identified biomarkers requires quantitative methodologies that

include mass spectrometry in addition to the classical methods of antigen–antibody reaction.

(5) Alterations of Metabolites and Metabolic Profiles

The study of sets of small molecules, which permit the tracking of altered metabolic profiles in chronic inflammatory, neoplastic and/or degenerative diseases, has found extensive development in the field of biomedical translational research over the last decade. Metabolic components of glycolysis; the tricarboxylic acid cycle; the urea cycle; the metabolism of some amino acids such as tryptophan, proline, or arginine; and the metabolism of fatty acids have been identified as potential biomarkers of cardiovascular, neurological, and/or neoplastic diseases. Metabolomic analysis requires the availability of high-throughput instrumentation with great analytical sensitivity, such as nuclear magnetic resonance (NMR) spectroscopy or mass spectrometry associated with liquid or gas chromatography (LC-MS or GC-MS). The application of metabolomics within the clinical and forensic context includes the study of known metabolic profiles and the identification of new metabolites or panels of metabolites in the diverse biological fluids collected from the patients.

In conclusion, there is a need for biological markers capable of objectifying a physical and/or psychic impairment/disability, especially if the symptoms and signs of the functional loss pertain to the somatosensory or psychic sphere. In the near future, the systems biology framework and its bioanalytical platforms (partly described above) will favor the development and validation of new markers of functional weakening/loss, capable of enhancing the sensitivity and specificity of the ascertainment, providing objective evidence of the existence of the impairments/disabilities, and quantifying their functional implications.

1.3 Functional Brain Neuroimaging

The current imaging techniques for examining the anatomical structure and functioning of the human brain in vivo are often referred to as *neuroimaging modalities* and comprise five main platforms: functional magnetic resonance imaging (fMRI), positron emission tomography (PET), single-photon emission computed tomography (SPECT), multichannel electroencephalography (EEG), and diffusion tensor imaging (DTI).

Over the last two decades, fMRI has emerged as the dominant technique for functional brain mapping, at least in the research arena, with increasing translational applications in clinical and forensic medicine. Functional MRI is based on the physiological principle that an increase in the neural activity of a specific brain region correlates with an increase in the blood flow of that specific region. This blood flow variation leads to the blood oxygen-level-dependent (BOLD) signal, measured by the RMN detector as the ratio between oxyhemoglobin and deoxyhemoglobin signals, which are characterized by different magnetic properties

[9]. Thousands of fMRI investigations have been published in the last two decades, particularly in the field of cognitive neuroscience, neuropsychology, experimental psychology and sociology. They focus mainly on determining the distribution and patterns of brain activity associated with specific tasks.

Cognitive and neural fMRI probes can be adapted to include tasks of memory function, visual discrimination, reaction time, spatial, auditory and somatosensory processing, and executive functioning. In order to detect any abnormality in the above functions, individual fMRI data are compared to normative reference data. One of the current main challenges for bringing fMRI into medicolegal and forensic protocols is that the sensitivity, and even more the specificity, of the diagnosis depends on the statistical power of the normative data (i.e., the number of healthy controls included in the normative database).

Recent studies, nevertheless, have shown the elevated accuracy and precision of fMRI in the identification of activation patterns collected from single individuals, thus opening the field to a variety of applications in the area of personal injury and damage ascertainment, such as the functional characterization of dementia and neurodegenerative conditions, the objective diagnosis of purely psychological disorders (e.g., post-traumatic stress disorder, reactive depression), the objective quantitation of pain, lie detection, and/or malingering identification [10].

On the other hand, the tremendous expansion in the technological ability of PET and SPECT, as well as DTI, has given rise to the possibility of objectivizing a number of psychiatric syndromes causally correlating to anatomical and functional alterations derived from cerebral trauma or neurodegenerative diseases, thanks to the generation of comprehensive brain maps, called *connectomes* [11].

The integrated application of fMRI, PET, SPECT, and DTI has led to the construction of increasingly detailed maps of brain connectivity at high resolution, offering a powerful framework for localizing pathology, tracking patterns of disease, and ascertaining the functional compromise that results from an insult.

In the near future, the development of the *connectome topology* will enormously increase the understanding of the mechanistic causes of brain pathology, permitting the objective identification and prediction of cognitive and behavioral deficits resulting from a neurological or psychiatric pathology [11].

Since 2005, neuroimaging techniques, such as fMRI, PET, SPECT, and DTI, have been introduced in several civil and criminal proceedings across the world, with diverse verdicts of the trier of fact (i.e., judge or jury) concerning the admissibility of evidence. In order to meet the Daubert or Frye criteria, at least in the United States of America, the proposed methods must have undergone a process of validation on the part of the international scientific community at the basis of the method, on the quality of the evidence deriving from peer-review studies, and on the falsification of the method itself, in terms of "error rate." This expensive and academically complex enterprise must include, among its co-protagonists of the process of scientific validation, forensic psychiatrists and medicolegal experts dealing with personal injury and damage ascertainment, who are familiar with the current forensic framework and potential repercussions in terms of innovation and increase of the quality of the system derivable from the application of objective,

accurate, and precise neuroimaging methods to medicolegal issues such as personal injury, impairment, disability, and work capacity assessment.

1.4 Optical Coherence Tomography and Frequency Domain Imaging

This concerns biomedical imaging techniques that utilize light to capture micrometer-resolution three-dimensional images from within biological tissues, which, as is well known, are optical scattering media [12]. Depending on the properties of the light source (typically femtosecond lasers and supercontinuum lasers), optical coherence tomography can achieve sub-micrometer resolution (i.e., about 3–10 μm) having the following advantages in comparison to ultrasound, computed tomography, and/or magnetic resonance.

- Live subsurface images at near microscopic resolution.
- Instant imaging of tissue morphology.
- Noninvasiveness.
- Nonionizing radiation.

Currently, this technique is limited to imaging 3 mm below the surface of the biological tissue, because at greater depths the amount of light that escapes without scattering is too small to be detected. Several clinical applications have already been published regarding ophthalmology (e.g., imaging of the anterior segment of the eye and retina), neurology (e.g., assessment of axonal integrity), gastroenterology, pneumology, dermatology, interventional cardiology, and radiology.

Its second-generation implementation, called frequency domain optical coherence tomography (FD-OCT), exhibiting increased imaging resolution and acquisition speed, has been profitably applied to coronary investigation for detecting vulnerable plaques in asymptomatic patients, for investigating the morphology of the intima, the histological characteristics of the thrombus, and the thickness of the fibrous cap [13].

Thanks to its noninvasive nature and high axial (3–5 μm) and lateral (5–10 μm) resolution, FD-OCT has already been used to detect changes of the retinal tissue, particularly in macular degeneration [14].

Other interesting novel applications have been achieved thanks to the coupling of FD-OCT with endoscopy, in the field of gastroenterology for the diagnosis of precancerous lesions (i.e., early gastric cancer, Barrett's esophagus), for the study of the microscopic alterations correlated with celiac disease, in pneumology for the identification of micro neoplasms of the bronchial mucosa and in dermatology for the staging of cutaneous melanoma [14].

Furthermore, numerous clinical trials are underway aimed at testing the diagnostic utility of FD-OCT for imaging the lower gastrointestinal tract, solid organs such as the prostate, guiding needle biopsies or laparoscopic surgery, and

evaluating the morpho-functional characteristics of bronchia and alveoli in allergic asthma [15].

1.5 Photoacoustic Tomography

Photoacoustic imaging falls within the category of the novel vibrational imaging techniques, which can provide volumetric images of biological tissues in vivo with high spatial resolution at depths that far exceed the penetration capacities of conventional high-resolution optical imaging modalities (i.e., 1–2 cm).

It is based on the illumination of the tissue with short light pulses (i.e., in the nanosecond range), absorption by the cells, followed by thermoelastic expansion, and emission of ultrasonic waves, which are captured by ultrasonic detectors placed around the sample. In other words, photoacoustic tomography (PAT) produces images with optical absorption-based contrast, using deeply penetrable diffused light to excite photoacoustic signals. Apart from producing high-resolution images, this technique is safe for clinical use, is broadly applicable, and can furnish precious functional information on the organ or tissue.

Currently, PAT has four major implementations: raster-scan based photoacoustic microscopy (PAM), multispectral optoacoustic tomography (MSOT), rotation scan-based photoacoustic endoscopy (PAE), and hybrid systems coupling PAT to other imaging modalities, such as conventional ultrasound, optical coherence tomography, and MRI.

In recent years, PAT has been used in a number of preclinical applications, including imaging of angiogenesis, microcirculation, drug response, brain functioning, tumor microenvironments, biomarkers, and gene expression [16]. Coupled to an endoscopic system (PAE), it has also been applied on animal models for the in vivo imaging of the upper and lower gastrointestinal tracts [17].

In particular, PAM, utilizing a scanning focused ultrasonic transducer, has been profitably applied to the anatomical reconstruction of subcutaneous melanomas, as well as their microvasculature and lymphatic drainage. Indeed, PAM can depict blood vessels at ultrahigh resolution using oxyhemoglobin and deoxyhemoglobin as different light absorbers [18].

MSOT, with multiple illumination wavelengths for separating the optical reporter of interest from the background absorption, has already been used for functional imaging of blood vessels and for characterizing the morphology of atherosclerotic plaques.

Hybrid systems, integrating PAT with conventional pulse-echo imaging, have also been implemented for the detection of early stage neoplastic tissues and for characterizing the functionality of a diseased tissue. In addition to morphological and anatomical data, this novel vibrational imaging technique can provide physiological and functional information, such as cellular temperature, blood flow, and oxygen supply.

The properties of great optical absorption contrast, abundant penetration depth, noninvasiveness, absence of ionizing radiations, and functional imaging of the above-described techniques suggest several useful future applications in the field of clinical forensic medicine.

Mindful of the great success that forensic radiology has experienced in the last decade and is still currently experiencing, it is foreseeable that the above innovative in vivo imaging techniques will have a widespread diffusion in the field of personal injury and damage ascertainment, such as in the identification and characterization of visual impairments, the objectification of post-traumatic muscle or tendon injuries (e.g., whiplash-associated disorders), and the morphometric characterization of nerve damage (e.g., hypo-anosmia) and of any other functional loss or impairment, the detection of which implies a labor-intensive and not always reliable neurophysiological examination.

All of the above novel imaging techniques and their medicolegal applications, however, will have to pass a thorough validation process, in terms of sensitivity, specificity, reproducibility, and robustness before they can be used in any forensic case and be considered as scientific evidence at trial, in a civil or criminal proceeding.

1.6 Conclusions

The unique combination of the new bioanalytical and molecular imaging technologies is predictive for the objectification of currently undetectable osteo-musculofascial injuries, for the morphological and functional characterization of internal organ damage, for functional brain mapping, as well as for cancer mapping and staging and, therefore, for an accurate and precise assessment of the prognosis *quoad vitam* and *quoad valetudinem* and of the related nonpecuniary damages (e.g., impairment, disability, loss of chances, psychological-existential damage, etc.).

The extraordinary scientific and technological evolution of postmodern biomedicine implies a challenge and a great opportunity for the bio-medicolegal sciences of the third millennium which, in order to survive and not lose the disciplinary unity, will have to be able to develop new conceptual paradigms with the aim of diminishing the current fallibility of the ascertainment and contestability of the evaluation.

This implies, equally, the need to modify and expand the strategies for the recruitment of international and national scientific funding to be reserved for the implementation of scientific projects, with an awareness and understanding on the part of the whole medicolegal community that change is the only way to avoid being excluded from the innovation process. The above issue cannot be taken lightly for it is of vital importance: on it hinges the very future and survival of the medicolegal discipline, whose ethical priority must include the preservation of the unitariness, the development of evidence, and the great commitment in pre- and postgraduate education and training.

It is necessary, indeed, to be aware that, without the empowerment of human capital, there is no growth, culture, or innovation. Thus, today more than ever, the essential task is to prepare young people so that they may first identify, and then perform, their role in the modern society of knowledge: a society in which economic, social, and cultural development principally depends on the creation and sharing of knowledge and expertise. Today, we can truthfully say that we are living in a "global campus," where the elaboration of contemporary culture is being developed, which is no longer—as it once was—expressed and formulated only by Western culture but also by cultural traditions and intellectual communities of other continents, which are emerging at the same pace as the respective economies of their countries. These cultures are no longer—as was the case for many years—emanations of the West, passively absorbing topics and keywords, but new subjects participating as equal protagonists in a common educational process, a process that is closely related with the economy. Indeed, education continuously represents an antidote against poverty and the descent into underdevelopment and, at the same time, a factor of growth and innovation. Already in 2007, moreover, the Conference of the Ministers of Higher Education held in London highlighted the great influence that universities exercise over the development of modern society, thanks to their tradition as centers of knowledge, research, and creativity and the transmission of knowledge; and the key role that they perform in the definition and diffusion of the values upon which society itself is founded is essential.

On the other hand, this authentic improvement in quality required of the university and other scientific communities has been rendered indispensable by the process of globalization, which has radically transformed the conditions affecting competitiveness, throwing new light on the territorial dimension. A "mobile" territory such as this, traversed by continuous flows of information, knowledge, goods, people, and financial capital, if it is to compete at a global level, will have to redefine, first of all, the very dynamics of social construction and territory, beginning not only from administrative borders but also and predominantly from those relating to cognition and relations between places.

In order to develop human capital, today it is not enough to provide a large number of students with a set of notions to be applied in a standard form during their working lives. That which educators call "expertise," namely, the ability to mobilize personal resources (meaning knowledge, know-how, approaches) and external information resources, is necessary, so as to be able to effectively respond to unfamiliar situations. It is important to teach how to proceed on a global scale, to reason in universal terms so as to become accustomed to interacting and competing within an ever more complex world, with cultural, linguistic, ethical, and religious diversity.

All of the aforementioned can act, furthermore, as an indirect and powerful invitation to refuse any form of limitation in terms of identity and locale. If the occurrence of planetary global warming is real, then there is an analogous process in relation to conscience, connected to some extent to a distorted conception of existence that assigns absolute priority to the idea of profit, subordinating everything to that, including education: with the risk, as noted by the American scholar

Martha Nussbaum, to create "generations of docile machines rather than fully fledged citizens, able to think for themselves."

If it is true that wisdom is difficult to teach, it is also true that, as Plato reminds us in *Philebus*, "wisdom is the right measure of knowledge and pleasure." Within the very DNA of the university and the scientific communities, the objective is not to "produce" as a function of the labor market but to teach "to learn how to learn," that is, by providing the tools to remain critical and at the same time competitive in the labor market but also open to cooperation in solving the major issues of humanity.

Today there is a great need to view the world from outside disciplinary limitations, with a unifying, not sectoral, perspective. And at the same time, the main current of the economy of knowledge, of strategic importance now and, even more, tomorrow, teaches us to invest in human capital, that is, in its continuous, not contingent, education. It is a message to be taken on board, since it refers directly to the responsibility of our academic institutions, and of ourselves, who are called upon to animate their foundational spirit in a modern key: which is that of educating toward a critical mentality and a democratic citizenship of the world, wherever one lives and acts. The deepest meaning of the university and scientific community is the safeguarding and transmission of knowledge of the past together with the defense of the idea that it is feasible to innovate such knowledge. A task, that of innovating knowledge with the aim of setting in motion the world, which coincides with the true identity and establishment of the university at the beginning of the last millennium, as a carrier of messages of universal value, in addition to values of freedom, pluralism, moral integrity and passion for research, expressions of the legislative autonomy of the intellect and culture.

In final conclusion and in line with the thinking of the anthropologist Marc Augé [19], the bio-medicolegal sciences of the post-genomic era will be able to "turn to the future without projecting illusions onto it but by creating hypotheses so as to test their validity."

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