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The Fingerprints of Biomedical Science in Internal Medicine

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Abstract

With the development of numerous advances in science and technologies, medical science has also been updated. Internal medicine is one of the most valuable specialized fields of medical sciences that review a broad range of diseases. Herein, the internal medicine specialist (internist) is obliged to do diagnostic measures to evaluate disease signs and symptoms. In recent times, biomedical sciences as the new emergence science (including cellular and molecular biology, genetics, nanobiotechnology, bioinformatics, biochemistry, etc.) have been capable of providing more specific diagnostic methods together with techniques for better understanding the mechanism of the disease and the best diseases modeling and offering proper therapies. Accordingly, the authors have tried to review the link between biomedical sciences and medicine, particularly internal medicine.

Keywords

Advanced technology · Biomedical research · Internal medicine · Medical informatics · Molecular diagnostic techniques · Regenerative medicine

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Abbreviations

CAR T cell	Chimeric antigen receptor T cells
CFTR	Cystic fibrosis transmembrane conductance regulator

CNB	Core needle biopsy
CT	Computed tomography
DNA	Deoxyribonucleic acid
EBUS	Endobronchial ultrasound
ECG	Electrocardiography
ELISA	Enzyme-linked immunosorbent assay
EMBL	The European Bioinformatics Institute
EMG	Electromyography
FNA	Fine needle aspiration
GGBN	Global Genome Biodiversity Network
GI	Gastrointestinal
GWAS	Genome-wide association studies
HRT	Hormone replacement therapy
IBD	Inflammatory bowel disease
IL	Interleukin
KNB	Knowledge Network for Biocomplexity
MR	Magnetic resonance
MRA	Magnetic resonance angiography
MRI	Magnetic resonance imaging
NCBI	National Centre for Biotechnology Information
NGS	Next-generation sequencing
PCR	Polymerase chain reaction
PET	Positron-emission tomography
PTH	Parathyroid hormone
RNA	Ribonucleic acid
SCID	Severe combined immunodeficiency
SPECT	Single-photon emission computed tomography

1 Introduction

Before the advent of medical science, people believed that the cause of many diseases was supernatural and should resort to magic for treatment (Major 1954, Ackerknecht and Haushofer 2016). Gradually, the use of medical sciences with the approach of herbal medicine was formed among ancient civilizations such as Greece, Babylon, Egypt, China, and India (Organization 2002; Weatherall et al. 2006; Hajar 2012; Jamshidi-Kia et al. 2018). With the passage of time and the creation of numerous advances in science and technologies such as pharmacology and drug production, medical science has also been upgraded (Weatherall et al. 2006). In this respect, medical specialists are trained for the treatment of special disorders in various organs of the body (Weiland et al. 2015). Herein, internal medicine as one of the most efficient specialized fields of medical sciences examines and treats a wide range of diseases, disorders, and syndromes such as rheumatologic, immunologic, allergic, endocrine and metabolic, infectious, pulmonary, etc. On the other hand, during facing an unknown cause disease, an internal medicine specialist can usually give the best advice, because they are known as specialists with comprehensive information on a wide range of diseases (West and Dupras 2012). In all specialized medical disciplines, the physician is required to use methods to diagnose the signs and symptoms of the disease and ultimately prescribe appropriate treatment. In this context, choosing the proper diagnostic methods is often a challenging issue, because many of the signs and symptoms are nonspecific or common to many diseases (Crombie 1963; Organization 2018). Hereupon, in recent centuries, the emergence and development of biomedical sciences with different approaches including cellular and molecular biology, genetics, nanobiotechnology, bioinformatics, biochemistry, etc. have been able to prepare more specific diagnostic methods (e.g., molecular imaging) along with methods to study the mechanism of the disease and provide the best practices for diseases modeling. Moreover, it can also offer modern therapies (e.g., regenerative medicine). In other words, biomedical sciences have played a significant role in the advancement of medical science around the world (Cambrosio and Keating 2001; Wade and Halligan 2004; Quirke and Gaudillière 2008; Gwee et al. 2010; Blann and Ahmed 2014; Fuller 2017). Here, the authors have sought to review the connection between biomedical sciences and medicine, especially internal medicine, as one of the most general medical disciplines.

2 Internal Medicine: Background and Present Status

Internal medicine as a branch of medicine deals with the prevention, diagnosis, and medical treatment of diseases in adults through understanding the basic pathological causes of symptoms and signs of patients. Throughout the history of medicine, during the nineteenth and twentieth century, the combination of three way of medical thinking including the anatomoclinic, the physiopathologic, and the ethiopatogenic mentality led to the emergence of new conception, holistic medicine or medicine of the person, in Europe. In this regard, the "internal medicine" expression originated from a German term *Innere Medizin*. Additionally, owing to the first written book about the internal diseases and the first convened world congress of internal medicine during that period, the twentieth century has been mentioned the golden century of internal medicine (Fordtran et al. 2004; Amatriain 2007). Nowadays, internal medicine has diverse subspecialties including rheumatology, pulmonary disease, hematology, endocrinology, nephrology, gastroenterology, etc. that the internists can follow specialty training in internal medicine if they wish.

2.1 Common Diagnostic Methods

In addition to history taking and accurate physical examination, how to reach differential diagnosis and final diagnosis is an important step in managing the patients. Nowadays, novel achievements in technology and basic sciences had shed light on the future of different fields of medicine and improve the diagnosis and management of the patients. In this regard, internal medicine has also benefited greatly in clinical approaches by applying para clinical investigations including laboratory and imaging investigations. The common diagnostic methods including imaging, laboratory data, pathology, etc. have their own pros and cons. Different imaging technologies assist the internists a lot in different areas and subspecialties. Laboratory testing plays a pivotal role in screening, diagnosis, treatment planning, and follow-up not only in internal medicine but also in every field of medicine. In recent years, new immunologic-based tests such as enzyme-linked immunosorbent assay (ELISA) and Western blot analysis are routinely applied in medicine (Swanson et al. 2018). Imaging is known as one of the noninvasive diagnostic method in medicine. Different imaging techniques like X-ray, computed tomography (CT) scan, magnetic resonance imaging (MRI), ultrasound, positron-emission tomography (PET), etc. through providing images from internal tissues and organs help internists in the diagnosis and management of diseases. The major advantage of MRI and ultrasound over the previous modalities is lack of X-ray and reduced the exposure to ionizing radiation. Due to the ability of MRI in showing the soft tissues and vasculature with high resolution, it is widely applied in many fields of medicine. Different methods of MRI are available: functional MRI (brain mapping) and magnetic resonance (MR) spectroscopy (measuring the chemical components of tissues, e.g., the brain tumors). One of the best modalities with high sensitivity for diagnosing the acute ischemic stroke is diffusion-weighted magnetic resonance imaging. PET as a functional imaging technique is broadly performed to evaluate the malignancies and their spread. Fluoroscopy, angiography, magnetic resonance angiography (MRA), and single-photon emission computed tomography (SPECT) are some the other imaging techniques (Ahn et al. 2002; Hansell et al. 2009; Kang et al. 2009; Goodarzi et al. 2019d). Pathological study is another diagnostic method which needs bio-fluids and tissue samples. Various methods are applied for obtaining tissue samples including fine needle aspiration (FNA), core needle biopsy (CNB), and open incisional/excisional biopsies. Hence, pathological study unlike the other methods often is an invasive diagnostic method (Tayanloo-Beik et al. 2020). Furthermore, there are other modalities applied in subspecialties of internal medicine. Accordingly, endoscopy, colonoscopy, rectosigmoidoscopy, endobronchial ultrasound (EBUS), electrocardiography (ECG), echocardiography, and electromyography (EMG) are some of these modalities. Although all of the above-discussed methods most of the time assist the internists, sometimes these common diagnostic techniques are not sufficient enough, and their sensitivity and specificity are different. Hence, novel tests and methods are required to progress the diagnosis and management of patients.

2.2 Common Treatment Options

Internists, unlike the surgeons, commonly deal with medical treatments. Prevention, diagnosis, and treatment are the basis of an internist career. Prevention has some levels that internal medicine can concern with various levels in different ways. Accordingly, recommendations for changing lifestyle, screening, and treatment for preventing/limiting the progress of diseases and their complications are examples of internal medicine role in prevention. Besides the wide range of treatments applied in internal medicine, the medication has an essential role among other options. Hormone therapy including hormone replacement therapy (HRT), insulin therapy, corticosteroid therapy, levothyroxine, and parathyroid hormone (PTH) replacement therapy is considered as one of the treatment bases in internal diseases (Forsblad d'Elia and Carlsten 2006; Cutolo 2010; Gluvic et al. 2015). Recently, interventional therapy by novel achievements finds a special place in various subspecialties of internal medicine. In this regard, coronary angioplasty with or without stenting in cardiology, endoscopic and colonoscopic intervention for sphincterotomy, stent placement, stone removal, polypectomy, clip application, submucosal injections in gastroenterology, radiology-guided intra-articular/periarticular/myofascial trigger point injection in rheumatology, ultrasound-guided renal biopsy, and insertion of peritoneal dialysis catheters in nephrology are some examples of interventional therapies (Khan 2005; Efstratiadis et al. 2007; Lee-Kong and Feingold 2017; Ramírez and Plasencia 2018; Tseng et al. 2019).

3 Biomedical Science: Subsets and Applications

Biomedical sciences (*biomedicine*) include a set of natural science disciplines which help advance the goals of medical science by using physiological and biological principles. The mentioned natural science disciplines include cellular and molecular biology, genetics, biochemistry, bionanotechnology, bioinformatics, bioengineering, microbiology, embryology, and physiology (Kirschner et al. 1994, Cambrosio and Keating 2001, Pal 2007, Quirke and Gaudillière 2008, Nass et al. 2009, Arjmand et al. 2020d, e).

3.1 Cellular and Molecular Biology

Cellular and molecular biology is a science which generally studies the function, evolution, and development of the cellular structures of living organisms and their molecular basis. The mentioned studies include investigating cells and molecules' interaction with each other and the environment (Weatherall 1998; Karp 2009; Wei and Huang 2013; Alberts et al. 2018). In other words, it evaluates cellular and molecular signaling and metabolic pathways as well as the cell cycle regulation. Furthermore, molecular biology strongly overlaps with some other biological sciences including genetics and biochemistry (Swanson 2018). Indeed, cellular and molecular biology studies can help physicians to understand the precise pathogenesis of the disease (Beenhouwer 2018; Williams and Silverman 2018). On the other hand, it can be important for the development of diagnostic methods. In other words, cellular and molecular diagnoses, including the analysis of different cell phenotypes and tissue derivatives along with the measurement of various macromolecules and metabolites, can indicate the presence of a disease and abnormal body function (DeBerardinis and Thompson 2012; Tan 2016; Raghavendra and Pullaiah 2018). Further, cellular- and molecular-based diagnoses can improve simulating the disease in appropriate preclinical models (including cell-based and animal models) and lead to select the most appropriate treatment options. Additionally, investigations based on cellular and molecular sciences have opened a new window of therapeutic approaches, including cell therapy and regenerative medicine (Weatherall 1998; Wang et al. 2013).

3.1.1 Biochemistry

Biochemistry (investigation of chemical compounds and essential chemical processes in living organisms) and medicine share a relationship of mutual collaboration. In other words, biochemical experiments have shed light on multiple phases of the disease (Kogut 1977; Baynes and Dominiczak 2009). Herein, different diseases are classified as being associated with the main types of biochemical molecules (including proteins, carbohydrates, lipids, and nucleic acids) and their related signaling pathways (Stryer et al. 2002; Blanco and Blanco 2017).

3.1.2 Genetics

Genetics as a branch of biology investigates the genetic material in an organism (including deoxyribonucleic acid (DNA) or ribonucleic acid (RNA)), genes (as sequences of nucleotides in DNA or RNA), genetic variations, and heredity (Griffiths et al. 2000). Also, genetic studies (by high-throughput methods, i.e., genome-wide association studies (GWAS) and next-generation sequencing (NGS)) can play a pivotal part to develop understanding of the several disease (e.g., diabetes, obesity, arthritis rheumatoid, Alzheimer's disease, Parkinson's disease, etc.) mechanisms via evaluation the specific involved biological pathways in pathogenesis and implementing accurate diagnostic methods (Edwards 1963; Claussnitzer et al. 2020; Jackson et al. 2020) (Fig. 1). Accordingly, understanding the mechanism of disease can lead to ameliorating therapeutic tactics and finding novel biomarkers and drug targets. Moreover, advances in genetic studies have led to the emergence of a new and effective treatment called gene therapy as approach for improving mutant genes (altered genes) or site-specific modifications (Abati et al. 2019).

3.2 Bioinformatics

Bioinformatics is the use of computing, statistics, and research techniques to collect, analyze, and handle data in recent biology and medicine. In this context, physicians and biologists can detect the structure of biological molecules, e.g., nucleic acids and proteins, via accessing the Internet and bioinformatics-related websites (Table 1), together with simple bioinformatics methods (Lesk 2019; Azodi et al. 2020; Baxevanis et al. 2020). Additionally, bioinformatics has become an important component of omics (genomics, transcriptomics, proteomics, and metabolomics) (Fig. 2) investigations (Mayer 2011; Schneider and Orchard 2011; Yadav 2015). The goal of omics investigations is to identify and quantify the biological molecules on which the structure, dynamics, and function of organisms depend (Horgan and Kenny 2011; Agharezaee et al. 2018; Arjmand 2019; Gilany et al. 2019a, b c; Goodarzi et al. 2019a; Khatami et al. 2019; Larijani et al. 2019a, b; Mehrparavar et al. 2019; Mehrparvar et al. 2020; Tayanloo-Beik et al. 2020). Moreover, the broad omics information achievement can lead to biology development and contribute to the emergence of system biology (research area which focuses on the understanding of whole biological processes, i.e., metabolic pathways and gene regulation) (Chen and Snyder 2012; Yan et al. 2018). On the other hand, individual omics evaluation is expected to lead to substantial improvement in personalized medicine (Chen and Snyder 2013; Ibrahim et al. 2016).

3.3 Bioengineering

Bioengineering uses a range of sciences such as mathematics, biomechanics, tissue engineering, and polymer science to design and develop some areas (including medical devices, diagnostic instruments, biocompatible products, ecological engineering, agricultural engineering, etc.) in order to improve living a healthy lifestyle in this modern world (Valentinuzzi et al. 2017; Sharma and Khurana 2018).

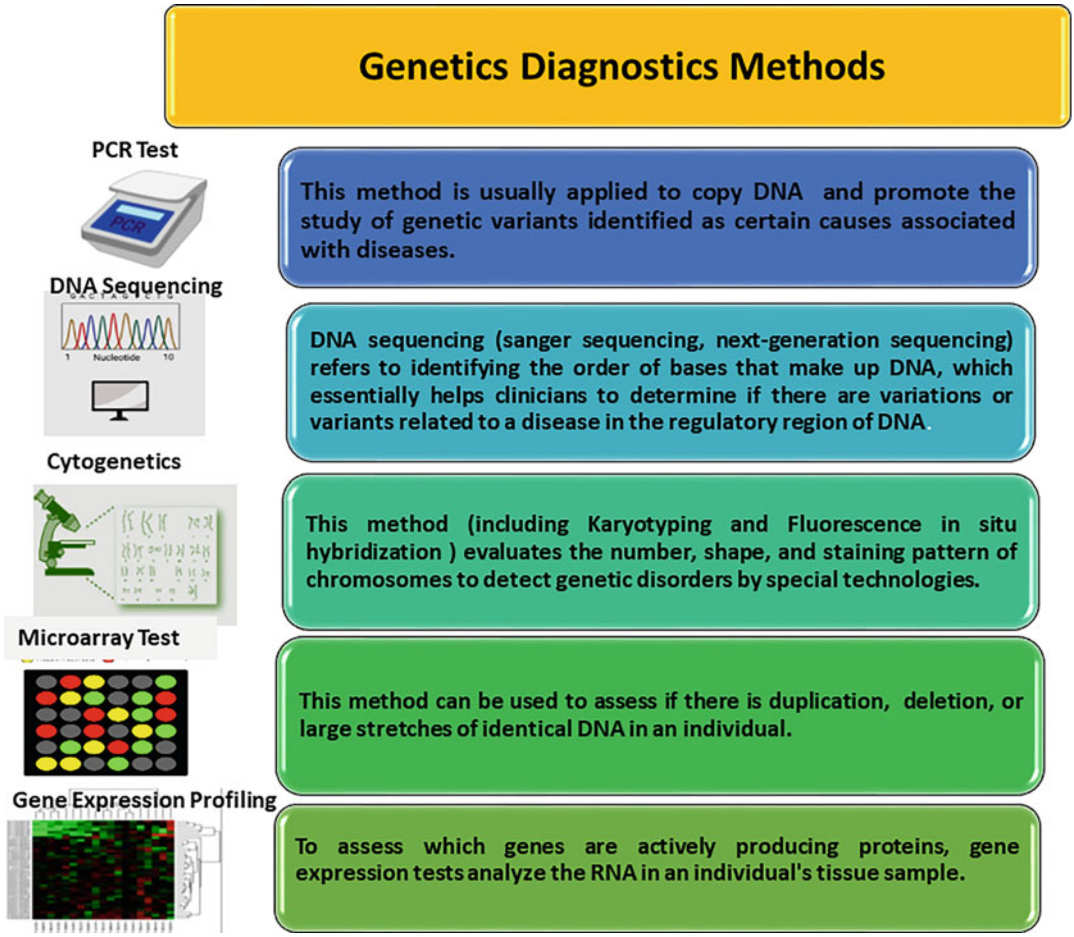

Fig. 1 Genetics diagnostic methods. Genetics diagnostic methods are including polymerase chain reaction (PCR), DNA sequencing, cytogenetics, microarray testing, and gene expression profiling which help look for disease mechanisms (Dwivedi et al. 2017)

3.4 Bionanotechnology

Bionanotechnology, which involves many scientific fields such as cellular and molecular biology, physical sciences, bioengineering, chemistry, nanotechnology, and medicine, can incorporate biological molecules into nanotechnological applications. In other words, it uses knowledge of the characteristics acquired by living organisms on the evolutionary path for technological purposes. Hereupon, the production and design of multifunctional nanoparticles focuses on improving diagnostic techniques, drug delivery system, and therapeutic approaches (Kumar et al. 2013; Ramsden 2016; Zhang et al. 2017; Rauta et al. 2019).

3.5 Microbiology

Microbiology that investigates microscopic organisms (viruses, bacteria, fungi, protozoa, and archaea) includes fundamental evaluation of microorganisms' physiology, cell biology, biochemistry, and ecology. In this respect, it offers services to help diagnose and manage infectious diseases (Glazer and Nikaido 2007; Brooks 2013; Murray et al. 2020).

Table 1 Some of the useful bioinformatics websites

Websites	Application and services
Allen brain atlas	It can provide a unique online public source of broad gene expression, connectivity, and neuroanatomical data about the brain in mice, humans, and nonhuman primates
BLAST	It can be applied to understand functional and evolutionary connections between sequences and recognize gene family members
ChemSpider	It can provide instant access to more than 67 million chemical structures from hundreds of data sources
The European bioinformatics institute (EMBL)	It provides a freely accessible and up-to-date comprehensive collection of molecular data resources
ExPASy	It can provide access to over 160 databases and software resources for the study of genomics, proteomics, structural biology, evolution and phylogeny, system biology, and medical chemistry as an extensible and integrative portal.
Global genome biodiversity network (GGBN)	It can provide a set of vocabulary designed to describe samples of tissue, DNA, or RNA linked to voucher specimens and samples of tissue
Knowledge network for biocomplexity (KNB)	It is an international repository designed to promote environmental and ecological studies around biocomplexity
National Centre for biotechnology information (NCBI)	It can provide access to biomedical and genomic data

Altschul et al. 1997; Andelman et al. 2004; Kanz et al. 2005; Dong 2008; Pence and Williams 2010; Artimo et al. 2012; Barrett et al. 2012; Droege et al. 2014

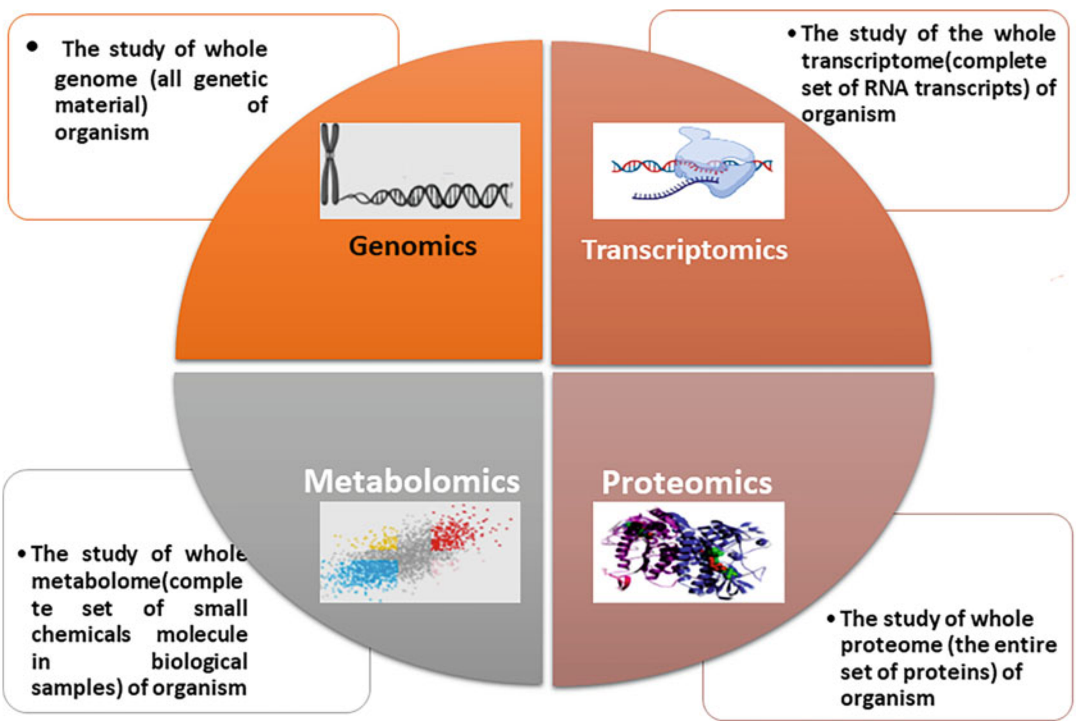

Fig. 2 Omics technologies. Omics technologies seek to the studying of whole genome (genomics), mRNAs (transcriptomics), proteome (proteomics), and metabolome (metabolomics) in specific biological sample (Arjmand 2019; b; Larijani et al. 2019a, b)

3.6 Embryology

Embryology studies the evolutionary and development procedure of various tissues of the living organism from the embryonic stage. In addition, embryological investigations can be effective in the treatment process of fertility-related disorders as well as advancing tissue engineering studies (Patten 1954; De Ferraris and Muñoz 2009; Appasani and Appasani 2010).

3.7 Physiology

Physiology is a branch of biology which concentrates on the biomolecules, cells, and organs' mechanisms of function in a living organism. Indeed, it evaluates the chemical and physical mechanisms (Withers 1992; Ganong 1995; Feder et al. 2000).

4 Molecular Diagnostics and Multi-Omics Approaches

Molecular diagnostics is a group of techniques used to examine biological markers in the genome, proteome, and metabolome. In the recent decades, molecular diagnostics has undergone a period of rapid growth and development (Chehab 1993; Buckingham 2019). Moreover, to advance the goal of achieving proper treatment, it is important to introduce new high-throughput technologies in a clinical molecular diagnostic laboratory. In this context, one of the promising technologies for accelerating the detection process is molecular detection by analytical omics along with using different nanotechnologies (application of numerous nano-devices and nano-systems) (Quezada et al. 2017; Chakraborty et al. 2018; Mukherjee et al. 2020).

4.1 Molecular Imaging

Molecular imaging as part of medical imaging techniques focuses on the use of specific imaging molecules (special probes, i.e., metal ion and radioactive isotope which is injected into a specific anatomical location of living organisms) and imaging modalities (i.e., MRI, CT scan, and PET scan) with the aim of noninvasively studying at the molecular and micromolecular level. The mentioned imaging technique is used to identify metabolic pathways and tissue structures and to evaluate small laboratory animals. Recently, it is applied specifically for infectious diseases, congenital abnormalities, and cancer subjects, from diagnosis to therapy (Aghayan et al. 2014b; Abou-Elkacem et al. 2015; Haris et al. 2015; Saadatpour et al. 2016; Saadatpour et al. 2017).

4.2 Single-Cell Multi-Omics Analysis

Recent technical advancements (including groundbreaking single-cell assays) are promising to overcome the limitation of genome-wide assays (which offers an average of a large number of cells). Accordingly, single-cell sequencing is now becoming available for genomes, transcriptomes, proteomes, and metabolomes, and it provides unprecedented insights into basic biology and biomedicine. Single-cell multi-omics profiling may fix problems that are difficult for other techniques. Hereupon, the genotypic and phenotypic heterogeneity of bulk tissue can be analyzed by single-cell sequencing technology. Indeed, it promises to extend our knowledge of the fundamental processes that control both health and disease (Bock et al. 2016; Hu et al. 2018; Packer and Trapnell 2018; Lee and Hwang 2020; Samir et al. 2020).

5 Advanced Preclinical Models

To simulate a human disease condition (e.g., psychiatric disease), using preclinical models in biomedical studies has become near-universal. Additionally, preclinical models can increase knowledge of cellular signaling pathways and recognizing possible drug targets and novel treatment options (Pan et al. 2020; Scearce-Levie et al. 2020). In this respect, since the past, the use of animal models (especially mammalians) has been popular (Goodarzi et al. 2019d; Larijani et al.

2019a, b; Arjmand et al. 2020b; Baradaran-Rafii et al. 2020). Herein, extrapolating outcomes from models to humans have become an important topic in the evaluation process of the novel treatments. Moreover, based on recent investigations, some biological conditions (such as mental development) have been described which are unique to the human and cannot be modeled in other organisms. In this context, to overcome the mentioned limitations, the advent of in vitro approaches to 3D cell culture systems (employing the genetic engineered stem cells derived from various tissues) or organoids as fast-emerging technology has drawn extensive attention. Organoids (Fig. 3) are able to regenerate, reorganize themselves, and display the function of organs (Li and Izpisua Belmonte 2019; Maximino and van der Staay 2019; Duque-Correa et al. 2020; Jimenez-Palomares et al. 2020; Kim et al. 2020).

6 The Next Generation of Treatments

New breakthroughs in science show great promise in the future of medicine through novel alternative treatments. In this respect, cell-based and gene-based therapies in recent decades greatly progress and become some light of hope for the treatment of incurable diseases. On the other hand, a modern mantra emerging in healthcare is personalized medicine which is powered by providing the clinical, genetic, and environmental knowledge of each individual.

6.1 Cell-Based Therapies

Recently, cell therapy and regenerative medicine are extensively considered in various area of

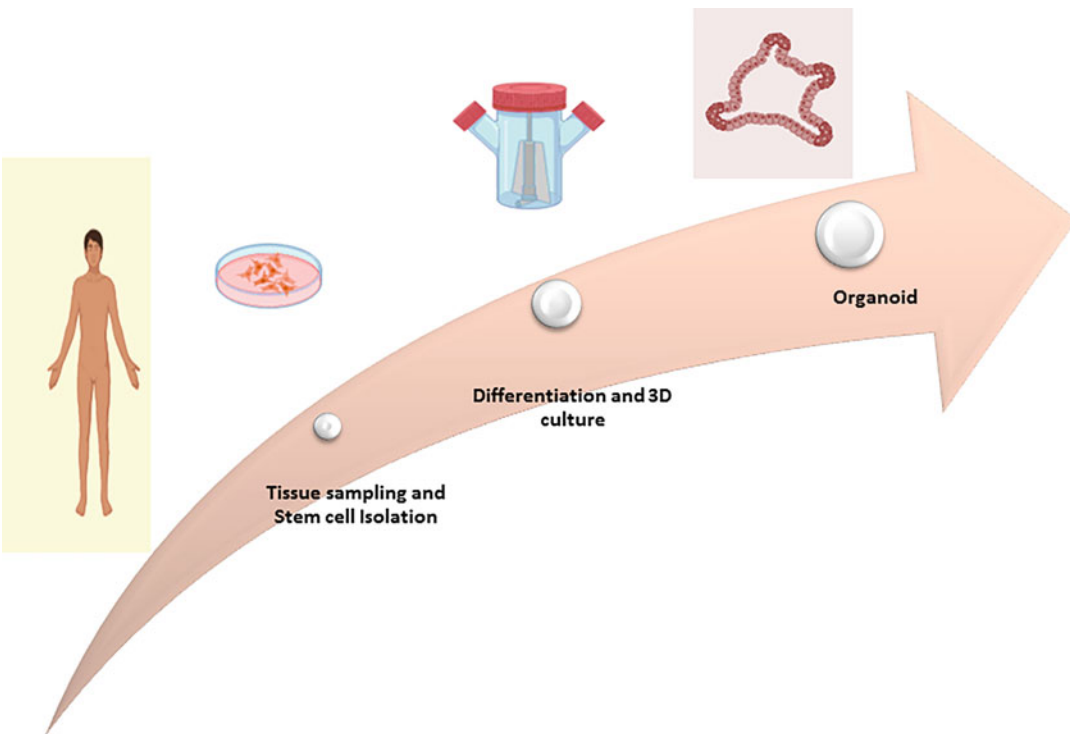

Fig. 3 Three-dimensional (3D) organoid culture. Organoids are 3D cell cultured models which include a population of self-renewing stem cells that differentiate into multiple forms of organ-specific cells and finally show a spatial organization similar to their origin organ and are capable of imitating a highly physiologically certain functions of that organ (Kaushik et al. 2018)

medicine, especially in internal medicine (Arjmand and Aghayan 2014; Arjmand et al. 2017a; Goodarzi et al. 2018b, 2019b, c; Aghayan et al. 2020; Arjmand et al. 2020c, 2021; Ebrahimi-Barough et al. 2020; Hosseini et al. 2020). Different types of stem cell are now available and can be used to generate the healthy and functioning specialized cells, which can then replace diseased or dysfunctional cells. Investigations of cell therapy for cirrhosis, perianal disease of inflammatory bowel disease (IBD), cystic fibrosis of the lung, different types of lymphoma, chronic angina, heart failure, myocardial infarction, ischemic stroke, critical limb ischemia, Parkinson' disease, Alzheimer' disease, spinal cord injuries, etc. have significant progress, but most of them are not yet ready for routine clinical application (Saberi et al. 2008; Aghayan et al. 2014a; Arjmand et al. 2014, 2019a; Goodarzi et al. 2014; Larijani et al. 2014; Derakhshanrad et al. 2015; Goodarzi et al. 2015; Larijani et al. 2015; Shirian et al. 2016; Soleimani et al. 2016; Arjmand et al. 2017c; Rahim and Arjmand 2017; Goodarzi et al. 2018a, c; Payab et al. 2018; Rahim et al. 2018a, b, c, d; Larijani et al. 2020; Payab et al. 2020; Roudsari et al. 2020a, b). Hence, although regenerative medicine and cell therapy as a new technique of treatment have received widespread attention in recent decades, there are a lot of pitfalls in this field (Cho et al. 2015; Nguyen et al. 2016; Shah et al. 2018; Yong et al. 2018; Abramson et al. 2019; Chen et al. 2019; Guo et al. 2019; Hayes Jr et al. 2019).

6.2 Gene-Based Therapies

Gene therapy assists in preventing/treating/or curing disorders through introducing genes into cells (Hashemi et al. 2016; Arjmand et al. 2019b, 2020; Hasanzad and Larijani 2019). This technique is used in treating several inherited disorders; however, it is more feasible for diseases with a single gene involved. There are two types of gene therapy: somatic gene therapy and germ cell gene therapy. Results of the somatic gene therapy unlike the germ cell gene therapy will not be continued by the patients' offspring. Somatic gene therapy is acceptable for diseases such as cystic fibrosis, muscular dystrophy, cancer, inherited blindness, Parkinson's disease, etc. (Verma and Weitzman 2005; Larijani et al. 2019a, b). The first approved gene therapy is introduced in 1990 for severe combined immunodeficiency (SCID) (Ferrua and Aiuti 2017). Thereafter, this technique is applied for other blood disorders like thalassemia, hemophilia, and sickle cell anemia. Also, investigations for gene therapy of cystic fibrosis through introducing normal cystic fibrosis transmembrane conductance regulator (CFTR) gene are ongoing (Yan et al. 2015). Application of gene therapy in the field of cancer treatment was a hot topic in recent years. Accordingly, introducing tumor suppressor genes like p53 or cytokine encoding genes (such as IL 2) and chimeric antigen receptor T cells (CAR T cells) is an example of this application (Ginn et al. 2018). However, gene therapy is not considered to be applied routinely because of some safety and ethical problems such as probability of gene therapy effects on descendants of the patient.

6.3 Regenerative Personalized Medicine

Personalized medicine in biomedical sciences is a special modern treatment method in the current century. The inherent heterogeneity of patients, which indicates different prevalence, different clinical symptoms, and different treatment responses in individuals, families, and ethnicities, is considered to be a very important element in the method described. Personalized medicine needs an examination of the genotype, physiology, and clinical and behavioral details of each individual in order to diagnose and create a personalized treatment plan rapidly. The use of bioinformatics and omics technologies is very helpful in this context (Arjmand et al. 2017a, b, 2020b; Arjmand and Larijani 2017).

7 Conclusion and Future Perspectives

Internal medicine focuses on both acute and chronic diseases. In recent years, combination of technology with basic and medical sciences ameliorates the disease managements. Common available treatment options can cure some of the diseases. On the other hand, due to diverse reasons such as lack of knowledge about the pathophysiology of some diseases and the absence of effective therapeutic options, there are no curative treatments for some of the other diseases. In such circumstances, the goal of management is palliative care and to prevent the progression of disease and its consequences. Further, better understanding the etiology of diseases, new discoveries in basic sciences, novel advances in technology, and proper combination of these elements are required. Here through the experiments on human tissue and fluid samples carried out in high-tech laboratories, biomedical scientists have a huge effect on the development of innovative therapies for human diseases. In other words, the emphasis of biomedical research in medicine has specific advantages for the future of internal medicine and offers satisfaction with the application of fundamental science to the resolution of clinical problems. Therein, in the coming years, medical practice is expected to continue to evolve toward improved and personalized healthcare, with new techniques to be implemented in order to recognize and improve existing clinical limitations, with an increased effort to tailor medical services to each patient's unique characteristics. In order to understand and direct tailored strategies for an effective clinical context, technological advances and clinical trials can help. Hereupon, also the innovation in stem cell-based technology would enable this pathway such mentioned therapies can be readily accessible in medical procedures.

Compliance with Ethical Statements

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