IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 20, Issue 4 Ser.10 (April. 2021), PP 47-55
www.iosrjournals.org

The impact of patient faith on the selection of "permissible" biomaterials in pharmaceutical and biomedical fields

Mehdi Ebrahimi
Prince Philip Dental Hospital, The University of Hong Kong, Hong Kong

Abstract:
Currently, there are large numbers of commercial biomedical materials that are available for therapeutic and regenerative medicine. These biomaterials are frequently applied in orthopedic, trauma, maxillofacial, and dental fields. The importance of Halal pharmaceuticals and healthcare products has recently been emphasized; however, this issue has been largely neglected in the past. Although the Halal issue has been given priority in food industries to fulfill the Islamic regulations, little attention is made to the application of Halal healthcare, pharmaceuticals, and biomedical materials. Unfortunately, the availability of non-Halal biomaterials has been largely neglected and there is no well-known code or criteria among responsible bodies to address this issue even in Muslim countries with a long history of importing different biomaterials. Therefore, the concept of the Halal industry and Halal marketing in the healthcare system should be applied as it is involved with Halal food. This issue needs to be addressed urgently to stop the application of non-permissible biomaterials in patients with religious restrictions according to medical ethics. This paper highlights the importance of Halal biomaterials from an Islamic perspective and provides some outlines to clarify this issue in the healthcare system.

Key Word*:Biomaterials; Pharmaceuticals, Biomedical; Patient's faith, Medical ethics*

Date of Submission: 14-04-2021 Date of Acceptance: 28-04-2021

I. Introduction

According to medical ethics, the patient has the right to be informed by the treating physician about his treatment plan, the possible health risk factors, and the success or failure rate of the treatment. Similarly, the patient has to be informed about the nature of applied or prescribed medicine or biomedical materials. It should be noted that the patient has the right to accept or reject the treatment course knowing well the consequences and possible complications. Keeping this in mind, the healthcare provider should understand that certain faith or belief may influence or restrict the patient's choice of the overall treatment course. Islam, for example, provides strict regulation about the nature of consumed or applied materials. Knowing this, a healthcare provider should be well aware of these restrictions as part of his responsibility to share this knowledge with the patient. Failure to do so may end up with legal issues that ultimately result in problems forcing the healthcare provider to bear all the responsibilities. Therefore, the knowledge that prescription or application of some biomedical products may conflict with patient faith is no longer an optional fact but a must for all healthcare providers. However, today with the huge advancements in biomedical technologies, the study of the available biomaterials from the perspective of patient faith may be a challenging task. This chapter highlights the issue of Halal in pharmaceutical and biomedical biomaterials, the challenges for setting standard criteria for the Halal industry, and the need to create awareness among healthcare professionals, consumers, and patients.

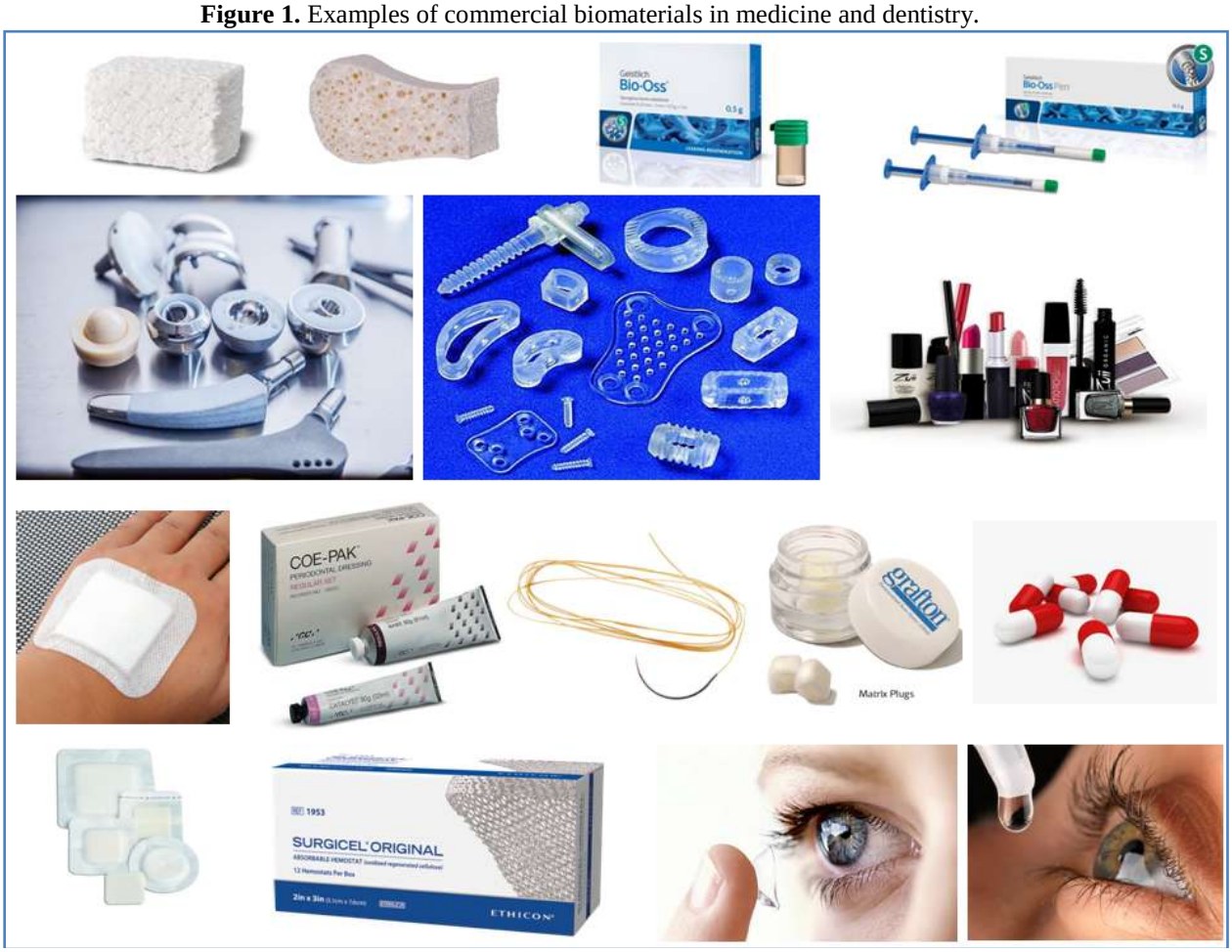
II. Background

Biomedical materials or biomaterials can be defined as "a substance that has been engineered in a simple or complex form to direct or control biological interactions within a living system during any therapeutic or diagnostic procedure, inhuman or veterinary medicine". However, the most accepted definition of biomaterials is described by the American National Institute of Health. According to their definition a biomaterial is "any substance or combination of substances, other than drugs, synthetic or natural in origin, which can be used for any period, which augments or replaces partially or any tissue, organ or function of the body, to maintain or improve the quality of life of the individual". [1]. '' The major difference of biomaterials from other classes of materials is their ability to retain their function in a biological environment for the required period, without damaging the surroundings or being damaged in that process [2].

Biomaterials play a critical role nowadays in therapeutic, diagnostic, and regenerative medicine and dentistry (Figure 1). They are available for restoring the function or enhancing a healing process in a patient with a disease or injury. The initial historical use of biomaterials dated back to ancient Egyptians using sutures

from animals or metal to restore the bony defect. Another early biomaterial application was loose teeth bounded together with gold wire to reduce tooth mobility and restore function. However, in modern medicine, the field of biomaterials integrates medicine, physics, chemistry, biology, and IT technology. Doctors, researchers, bioengineers, and material scientists are actively involved in innovations.

Figure 1. Examples of commercial biomaterials in medicine and dentistry.



The recent advances in biomedical technologies have resulted in hundreds of pharmaceutical, biomedical, and healthcare products that are derived from different sources. These biomaterials are being applied or consumed for therapeutic, regenerative, preventive, or cosmetic purposes. Examples of biomaterials broad range of applications include;

1. Restoring function: heart valve, artificial joint, dental implant, and stent.
2. Therapeutic and healing: suture, clip, staple, and biodegradable wound dressings, and drug-delivery system for target site delivery in cancer patients.
3. Regeneration: scaffolds, cells, and signaling molecules.
4. Diagnostic: nanoparticles for cancer imaging at the molecular level, a biosensor for blood sugar or brain activity monitoring.

Furthermore, the current fascinating technologies opened new horizons for the future of biomaterials. There are synthetic injectable biomaterials for the delivery of medicine, genetic agents, proteins, and macromolecules. These biomaterials are programmed for immunomodulation (i.e., autoimmune disease such as type 1 diabetes), treatment of bone disease, cancer, and repair of defective tissues.

As can be seen, the availability and variety of these biomaterials have confused the healthcare providers in a way that the proper selection and application become a critical issue nowadays. One of the main factors contributing to the failure of biomaterials is improper selection or application. Therefore, this is the main duty of a healthcare provider to be fully aware of the nature, quality, and performances of the biomaterials in hand. This knowledge would help them for the right selection and correct application of biomaterials. However,

this may necessitate further training with the biotechnology providers and attendance of relevant seminars and workshops.

In general, the biomaterials selection and application can be influenced by several factors including; the aim of the treatment, the biomaterials properties, and the patient-related factors, i.e., financial status, age, mental health, physical health, and cooperative level [3]. All of these factors play a critical role in the performance of these biomaterials in the body ultimately determining the success and failure rates.

A very important factor that is commonly and widely ignored is the extent to which the patient faith or belief may influence the choice of biomaterials [4]. It is a well-known fact that different faith or ethnic groups have different habits or concepts when considering food consumption. Moreover, certain types of food are prohibited according to some particular faith. For example, Islam, Judaism, and Hinduism restrain their followers from a certain type of food or products. All of these religions have their regulations and guidelines for the permissible type of consumed food.

According to Islamic teaching, the products of food consumed, used, or applied should be "*Halal*" or lawful. The word "Halal" is an Arabic word meaning lawful and permissible according to Islamic guidelines. In other words, it should be pure, clean, wholesome, and nourishing without known health hazards. This is summarized in the Arabic language as "Tayyeb". As such the word "Halal" and "Tayyeb" are used interchangeably for the same purpose.

The "non-Halal" or "non-Tayyeb" food or by-products have been clearly defined in Islam [5]. These could be a by-product or extract from any of the following lists:

1. Alcoholic drinks and intoxicating drugs,
2. Pigs and boars,
3. Dogs, snake, and monkey,
4. Carnivorous animals with claws and fangs; i.e., lions, tigers, bears.
5. Birds of prey with claws; i.e., eagles, vultures, etc.,
6. Animals not slaughtered according to Islamic requirements,
7. Animals killed by strangling or by a violent blow or by a head-long fall or by the goring of horns and those from which a wild animal has eaten, except it is slaughtered before its death (Holy Quran, chapter 5, verse 3),
8. Dead animals,
9. Blood,
10. Human cadaver,
11. Poisonous and hazardous products with known side effects, i.e., tobacco smoking.

The word "Halal" and "Tayyeb" have been mentioned several times in the holy book of Islam "Quran". For example, we read in the Holy Quran, chapter 16, verse 114, the translation as "then eat of what Allah has provided for you [which is] lawful and good. And be grateful for the favor of Allah, if it is [indeed] Him that you worship". Interestingly, the word "Halal" always came together with "Tayyeb" when GOD almighty (Allah) commanded mankind to eat from what God has created from food, meat, and other products. The word "Halal" and "Tayyeb" have been mentioned together in four different chapters including; chapter 2, verse 168, chapter 5 verse 88, chapter 8 verse 69, and chapter 16 verse 114. Considering this fact and the commands from the prophet of Islam (Muhammad bin Abdullah) in the form of Hadith (Sunnah), Muslim strictly adhere to these regulations and they strongly concern about the use of any illegal food or products which is generally known as "haram" (non-Halal) according to Islamic regulation. The word "haram" is an Arabic word meaning not-permissible or illegal.

Similarly, the Jewish law of "*kashrut*" refers to their dietary guidelines and restrictions. The word "*kashrut*" is a Hebrew word that means "fit" or "proper" to eat according to the Torah and Talmud law. Hence, the word "*kosher*" explains the food that meets the standards of *kashrut* that are prepared following Jewish law. Examples of these dietary guidelines include; the prohibition of what is considered "unclean" animals (pigs, shellfish, rabbits, and reptiles), and the mixing of meat (the flesh of birds and mammals) and dairy. The laws also define what are considered to be "neutral" foods (pareve) that can be eaten with either milk or meat [6].

The followers of Hinduism also have their regulations concerning consuming food or products. Hindu strictly adheres to "Sattva" as a guideline where all kinds of animal derivatives should be avoided. As such, they solely consume vegetarian or lacto-vegetarian kinds of food [7].

Though the basic teachings and regulations of religion are unchanging, the complexity of modern food science has challenged the follower of certain religions. Therefore, continuous interpretation and practical application of the religious regulations are unavoidable in response to the new advancements in industrialized food processing. The idea of Halal, kosher, and vegetarian certification industries with production oversight is introduced to help consumers find the required food with the aid of trademarked symbols.

Similarly, considering the impact of permissible types of food in different faiths, it is easy to understand the impact of patient faith on the nature of biomaterials or biomedical products which are applied or consumed. Unfortunately, this important fact has not been yet emphasized and it is frequently neglected by

many medical and dental practitioners, in addition to the unawareness of the patients. Therefore, the study of the nature of biomaterials by a healthcare provider and patient education should be the first step to address this problem considering both medical ethics and good practice.

III. Main Focus of the chapter

Considering the topic that has already been discussed, a quick look at the market reveals the fact that there are huge numbers of commercialized health products that are non-Halal, non-kosher, or non-sattvic. These biomaterials are applied or prescribed daily by a healthcare provider at clinics or hospitals without paying any attention to the possible patient religious concern. Although this practice is against medical ethics, the lack of knowledge of both the healthcare provider and the patienthasconcealed this fact somehow. However, with the recent advances in information technology and social media, the patients are becoming more educated and this issue getting more serious. Unfortunately, there are no criteria for the selection and application of Halal, kosher, or sattvic medical products. Furthermore, the level of awareness among healthcare providers and patients is not known. Anyway, as for the issue of informed consent in medical ethics concerned, the patient has all the right to be involved in the decision regarding their treatment plan. The healthcare provider must share enough knowledge about the nature and origin of applied or prescribed biomaterials considering the patient religious background [8,9]. Therefore, there is an urgent need to address this problem by respecting medical ethics professionalism to avoid medico-legal consequences in medical practice.

Of course, one of the easiest and fast solutions to this problem would be educating the patient, but, considering the current situation, it seems that the training of the healthcare provider is before patient education. Another possible solution to this problem could be a careful study of the nature of biomaterials by those who are involved in this field. This study is mandatory to categorize the healthcare products with Halal, kosher, or sattvic labels.

In general, biomaterials are broadly classified based on their origin into the natural and synthetic types. The natural biomaterials are derived from different sources of the living organism while the synthetic types are manufactured in the laboratory. Table 1 provides examples from each group.

Table 1. Natural and synthetic biomaterials available for the therapeutic purpose

Natural biomaterials		**Synthetic biomaterials**	
Types	Origin	Types	Example
Collagen	Cow, horse, pig, fish	**Metals**	Stainless steel (SS) Cobalt-chromium (Co-Cr) Titanium (Ti), Nitinol (Ni)
Gelatin	Cow, horse, pig, fish	**Ceramics**	Calcium Phosphates; HA, TCP, BCP Silica (Si): bioglass Alumina: Al_2O_3
Chitosan	Invertebrates, such as the exoskeleton of shellfish	**Hydrogels**	Polyacrylamide (PAAM) Poly(2-hydroxyethyl methacrylate) (pHEMA) Polyvinyl alcohol (PVA) Polyethylene Glycol (PEG)
Alginate	Brown seaweed	**Non-degradable polymer**	Polymethylmethacrylate (PMMA) Poly(ethylene terephthalate) (PET) Poly(tetrafluoroethylene) (PTFE) Silicones Polyurethanes (PU)
Silk	Arthropods; silkworms, spiders, flies, mites, or scorpions	**Degradable polymer**	Polyesters: poly(lactic acid) (PLA), poly(glycolic acid) (PGA), polycaprolactone (PCL), poly(lactic-co-glycolic acid) (PLGA), poly(propylene fumarate) (PPF) Polyorthoesters (POE) Polyanhydrides (PAH) Polyphosphazenes (PNE) Polyphosphoesters (PPE)
Cellulose	Bacteria		
Fibrin	Natural biopolymer formed during the coagulation cascade		
Bone	human cadaver, cow, pig		

Several types of natural and synthetic biomaterial have been commercialized and are in real use in clinical practice. Examples of such applications in medical practice are ophthalmic applications (Etafilcon A® and Vifilcon A®), contact lenses, eye wetting drops, wound dressings (Amerigel®), surgical sealants and sponges, barrier films, catheter coatings, cosmetic surgery (Aquamid®), bulking agent (Bulkamid®), osmotic

laxatives (MiraLAX® and GoLYTELY®), injectable intravascular emboli (Cartivat™), antimicrobial coatings, adhesion barriers (REPEL-CV®), and liquid sealants (ProGEL™, CoSealt™, and DuraSealt™). Other broad examples include a variety of controlled release medicines which are designed for the delivery of therapeutic or anti-tumor agents to the target site or tissue regeneration purposes (paclitaxel) [10,11].

Similarly, hundreds of biomaterials are also applied nowadays in dental practice. These biomaterials are applied for different purposes including; tooth filling, root canal treatment (RCT), treatment of periodontal diseases, treatment of periodontal and dental infection, guided bone regeneration (GBR), guided tissue regeneration (GTR), maxillary sinus augmentation for a dental implant, socket preservation, and prosthetic mouth rehabilitation [12–14].

Considering the variety of available healthcare products, it seems to be unrealistic and impossible to classify all biomaterials according to the patient religious background. However, good collaboration between the experts in each field would easily help to sort this problem. As per the expertise of the author, the bone substitute biomaterials can be addressed here. These biomaterials are being used in patients with bony defects due to several reasons such as trauma, infection, aging, or disease. Examples of such biomaterials are those applied in orthopedic, trauma, dental, and maxillofacial fields for bone reconstruction or repair (Fig. 1). These bone substitute biomaterials are generally categorized into five major groups; A) Metal and Alloy, B) Ceramic, C) Polymer, D) Macroscale composite and, E) Nanoscale composite [Table 2].

Table 2. Biomaterials in use for bone substitution.

Biomaterials	Examples	Applications
Metal and Alloy	Titanium, Stainless Steel, Co-Cr alloy	Bone plate, Bone implant, dental bracket, dental arch wire
Ceramic	Alumina, Zirconia, hydroxyapatite (HA), Tricalcium phosphate, Bioglass.	Hip joints, bone filler, bio-implant coating, maxillofacial reconstruction
Polymer	Collagen, Gelatin, Chitosan, polylactic acid, polyethylene (PE).	Bone plate, bone tissue scaffolds, pins, bone filler, bone drug delivery
Micro-scale Composite	HA/Collagen, HA/Chitosan, HA/Gelatin, HA/PE,	bone tissue scaffolds, middle ear implants, bone graft substitutes
Nano-scale Composite	nanoHA/Collagen, nanoHA/gelatin, nanoHA/Chitosan	Orthopedics, tissue engineering, drug delivery

However, in general, the bony defects can be repaired using any of the following four groups of the bone based on the nature of applied biomaterials;

1. Autograft: this is the gold standard bone grafting option because of its reliability and high success rate. It is obtained from the same individual, as such; the donor and receipt sites are within the same patient. The common donor sites include; calvaria, fibula, tibia, iliac bone, rib, ramus, andsymphysis of mandible bone, and maxillary tuberosity. This graft is advantageous because of its osteoconductive, osteoinductive, and osteogenic properties. However, the main challenges with autograft are their limited availability, extra surgery, and additional donor site morbidity [15]. Considering the religious guidelines, the use of autograft should have no restriction.
2. Allograft: this is a bone graft that is transplanted from one individual to another. It usually lacks osteoinductive properties but it can provide a structural template for host tissue to regenerate. It is usually obtained from the human cadaver tissue bank and processed technically (i.e., fresh-frozen or freeze-dried) to remove the antigenic factors minimizing the risk of disease transmission and immune reaction [16]. Today, the most common example is a demineralized bone matrix (DBM) which is produced by pulverization and acid extraction of natural bone. It consists of collagen, proteins, and different growth factors (i.e., BMP, IGF, TGF-β) depending on the manufacturing process [17,18]. Examples include; AlloWedge®, Allofuse®, Osteoselect®, Grafton®, Puros®, Allomatrix®, MinerOss®.
3. Xenograft: this is the bone that is taken from animal sources including, swine, bovine, or equine bone. Examples include; Stauman®XenoGraft (bovine bone +/- porcine collagen) and BioHorizonsMinerOss® X (bovine origin).
4. Alloplast: these are purely synthetic biomaterials that are entirely processed in the lab. Examples include Straumann® BoneCeramic® (biphasic calcium phosphate) and BioHorizonsNovaBone (dental putty).

Understanding the nature and the exact source of biomaterials' ingredients and their classification would help in the correctdecision-making for prescription and application of permissible biomaterials. This is mandatory according to medical ethics and informed consent if respecting the patient religious background and the possible restrictions. In this context, the study of biomaterials based on their origin would be useful for both the clinician

as well as the patient. For example,for bone tissue repair, biomaterials derived from the marine organism (i.e., fish, shellfish), alginate, chitosan, silk, and alloplastics are generally considered permissible in Islamic, Judaism, and somehow Hinduism faiths. However, there are different brands of commercial bone grafting biomaterials prepared from different sources (Table 3).

Table 3. Examples of commercial biomaterials applied in oral and maxillofacial practice for bone repair.

Brand	Product	Source
BioHorizons	Infuse bone graft Mem-Lok resorbable collagen membrane (RCM) Mem-Lok Pericardium BioStrip and BioPlug MinerOss X Collagen (Xenograft) Grafton (DBM)	Bovine Bovine Bovine Bovine Bovine Human
Geistlich	Bio-oss Bio-Oss collagen (Xenograft) Bio-Gide (membrane) Mucograft (membrane)	Bovine Porcine Porcine Porcine
Zimmer Biomet	BioMend&BioMend-Extend (collagen membrane) Collagraft (bone graft) Puros	Bovine Bovine Human
Mis-implants	4Bone RCM (membrane)	Porcine
Biomatlante	EZ Cure (membrane)	Porcine
Impladent	OsteoTape (bone graft matrix) OsteoGen Plug	Bovine Bovine
Integra Miltex	HeliPlug® (membrane) HeliMEND® and HeliMEND® Advanced (membrane)	Bovine Bovine
Symatese	Collapat II (graft)	Bovine
Osteogenics	Cytoplast RTM collagen (membrane)	Bovine
Matricel)	Remaix	Porcine
Botiss biomaterials GmbH	Collprotect® membrane Maxresorb® (graft) Maxgraft Cerabone	Porcine Alloplast Human Bovine
Straumann	AlloGraft XenoGraft XenoFlex BoneCeramic Membrane Flex Emdogain	Human Bovine Bovine + porcine Alloplast Porcine Porcine

It seems that the choice of alloplastic biomaterials could resolve the controversies in the patient with religious concern. This is because alloplastic biomaterials are not from living organisms but they are synthetic products manufactured in the lab during various chemical processes. However, the religious background of Halal, kosher, and sattvic products has invited serious debates and arguments in various aspects as a result of recent innovations in processing technologies. As such, it should be noted that the concern of non-Halal, non-kosher, and non-sattvic products could also involve trace additives that are frequently utilized during the manufacturing process of biomaterials. The insignificant presence of undisclosed non-Halal, non-kosher, and non-sattvic ingredients (i.e., Genetically Modified Organisms) may not alter the nature of biomaterials [19] but it can raise a serious conflict with the religious guidelines.

Therefore, from the religious point of view, one can criticize the exact chemical composition of biomaterials. From the manufacturing aspect, 100% pure biomaterials cannot be processed due to technical challenges. In fact, different types of additives are frequently used during biomaterials processing as a preservative, binder, emulsifier, or plasticizer agent. These additives are being used to improve the smell, appearance, consistency, and texture of the products or to prevent denaturation and decomposition. For example, different types of the carrier have been used as additives during the processing of demineralized bone matrices (DBM) such as; glycerol, hyaluronic acid, gelatin, and calcium sulfate powders [20]. Among these additives, many groups are categorized as non-Halal (haram) due to their swine or insectile nature. It should be noted that according to Islamic laws, the presence of even a minute percentage of non-Halal ingredients as additive renders the whole product non-Halal label. As such, the use of entirely synthetic biomaterials would be prohibited in a Muslim patient if traces of non-Halal additives are proved in these products. Therefore, non-Halal (*Haram*) biomaterials can be classified into two main groups:

1. the biomaterials that are directly and entirely prepared from non-Halal sources (i.e., dead animals, pigs, dogs, human cadaver, blood, some type of insects).
2. the biomaterials that are partially prepared using non-Halal additives.

Therefore, extra care should be taken to understand the nature and detailed composition of available biomaterials. This can be achieved by direct contact with the producer or further analysis and characterization by experts in this field. There is also the frequent release of reports that enumerates the non-Halal additives (i.e., E-code list) from different agencies such as Malaysian Halal Consultation and Training (MHCT) that is useful during material processing.

Another important issue is related to the processing, maintenance, storage, sterilization, and transportation of Halal biomaterials. It is mandatory to address these factors to maintain the quality of Halal biomaterials before their final applications. Therefore, attention to the following points is critical:

1. Halal biomaterials should be prepared, processed, or stored using purely 100% Halal biomaterials. Use of any non-Halal facility or material (as a whole or partly) is not permissible. For example, Halal biomaterials should not be stored in a package made from any non-Halal sources.
2. Halal biomaterials should not be in direct contact with non-Halal biomaterials during manufacturing, sterilization, transportation, or storage. However, they can be prepared or processed on the same premises provided the necessary measures are taken to prevent direct contact with non-Halal products.
3. Preparation, processing, storage, and transportation line of non-Halal biomaterials could be utilized for Halal biomaterials provided adequate cleaning procedures are performed according to Islamic guidelines.

In summary, an additional effort is required to understand the nature and detailed composition of available biomaterials as far the processing, storage, and transportation quality based on the understanding of the patient religious restriction. Although it is a challenging task it is the entire responsibility of healthcare providers to be first well aware of the nature of biomaterials in hand and secondly to inform and consent the patient.

Good Manufacturing Practices (GMP) by FDA, WHO, and other standard agencies and policymakers control the safety and quality of products, however, they failed to consider the biomaterials from the religious aspect. To fill this gap, the manufacturing companies, research centers, and related organizations and agencies are responsible for the introduction of new policies for the marketing and application of different biomaterials from the religious aspect.

IV. Future Trends

The importance of the Halal issue in the pharmaceutical, biomedical, and cosmetic biomaterials may be a new topic that needs to be highlighted. Although this topic was not a major concern in the past, however, the fast globalization of international marketing and the fact that Muslim countries are the main importer of these biomaterials have changed this mentality. Thousands of imported biomaterials are being used, consumed, and applied by healthcare providers and patients in Muslim countries as well as the Muslimsocieties in non-Muslim countries. Therefore, there is an urgent need to address this critical issue.

Thankfully, a similar issue because of the daily needs of Muslims to Halal food (i.e., meat, chicken) has been addressed well through the Halal certification organizations or bodies in different countries. They are responsible for analyses, inspection, and the issue of Halal certificates for food items (Table 4).

Historically, the idea of the Halal certificate was firstly initiated in the west in the 1960s by Muslim food and technical experts of United Status. This idea did not start in Muslim counties as the need was not concerned, however, it was started and propagated first by Muslims living in non-Muslim societies in the US, UK, Europe, and the AsiaPacific. The certification bodies came into action to fulfill the religious obligations of the Muslim minorities to guarantee their consumed products.

However, the idea was not invented by Muslims as the Jewish people have been observed earlier to enforce their religious requirement on products to be acceptable to them as "*kosher*". Later, through the globalization of the world trading system, the importing Muslim countries started to set a similar safety policy regarding the Halal issue (Table 4).

The majority of these agents are concerned about consumed Halal food and the issue of Halal biomaterials is still largely neglected. This is because of the lack of a link between these organizations and scientific parties such as universities and research centers. As such, these Halal certification bodies do not have adequateexpertise in the required field to properly address this critical issue.

Table 4. List of countries with examples of available Halal certification bodies

Country	Halal certification body
Australia	Global Australian Halal Certification (GAHC) Australian Halal Authority & Advisers (AHAA) Australian Halal Development & Accreditation (AHDAA) Supreme Islamic Council of Halal Meat in Australia Inc. (SICHMA)
Austria	Halal Quality Control

Belgium	Halal Food Council of Europe (HFCE)
Brazil	Federation of Muslims Associations in Brazil (FAMBRAS) Islamic Dissemination Centre for Latin America (CDIAL) Brazil
Brunei Darussalam	BahagianKawalanMakanan Halal Jabatan Hal Ehwal Syariah
Germany	Halal Control
Hong Kong	Asia Pacific Halal Council Co Ltd (APHC) The Incorporated Trustees Of The Islamic Community Fund Of Hong Kong Serving Islam Team (SIT)
India	Jamiat Ulama Halal Foundation Jamiat Ulama I-Hind Halal Trust
Ireland	Islamic Foundation of Ireland (IFI)
Italy	World Halal Authority (WHA)
Japan	The Japan Moslem Association (JMA) Muslim Professional Japan Association (MPJA)
Malaysia	JabatanKemajuan Islam Malaysia (JAKIM)
Netherland	Halal Feed and Food Inspection Authority (HFFIA) Total Quality Halal Correct Certification (TQHCC)
New Zealand	The Federation of Islamic Association of New Zealand, Inc (FIANZ) New Zealand Islamic Development Trust (NZIDT) Asia Pacific Halal Service - New Zealand (APHSNZ-Pty 2011 ltd)
Pakistan	Halal research council
Philippine	Halal Development Institute of the Philippines (HDIP)
Poland	The Muslim Religious Union of Poland (MRU)
Singapore	MajelisUgama Islam Singapore (MUIS)
South Africa	National Independent Halal Trust (NIHT)
Spain	Instituto Halal De Junta Islamica (Halal Institute of Spain)
Sri Lanka	Halal Accreditation Council (Guarantee) Limited
Switzerland	Halal Certification Services (HCS)
Taiwan	Taiwan Halal Integrity Development Association (THIDA)
Thailand	The Central Islamic Council of Thailand (CICOT)
Turkey	HAFSA Halal Certification and Food Imp&Exp Ltd Eurasia Halal Services Centre
UK	Halal Food Authority (HFA) – UK Halal Certification Europe (HCE)
USA	The Islamic Food and Nutrition Council of America (IFANCA) Halal Food Council USA (HFC USA) American Halal Foundation (AHF)
Vietnam	Halal Certification Agency (HCA)

Fortunately, in the AsiaPacific region, there are relevant centers that have started recently to address this topic. The Halal Institute at Prince of Songkhla University (Thailand) and the International Institute for Halal Research and Training (INHART) at international Islamic University (Malaysia) are two examples of relevant centers that do provide training, workshop, seminar, and analysis facilities for Halal certifications. The successful conduction of the "international conference on Halal innovation in products and services 2018 to strategize global Halal business through research and innovation" was a hallmark start, where I had the chance to share this important issue as a guest invited speaker. Through similar conferences, experts from different backgrounds and sectors have better opportunities to share, discuss, and cooperate for setting problem-solving strategies.

The development of sound Halal knowledge at an international level and the establishment of a professional platform for the Halal lifestyle should be the ultimate goal. This cannot be achieved except through a close collaboration between academia, governmental agencies, industries, hospitals, and social media to come up with the possible practical solutions that can be implemented. The responsibilities should be shared as suggested below;

1. The responsibility of academia: the medical/dental universities or colleges are responsible to add this critical issue into the study curriculum of future healthcare providers. Of course, it is not necessary to study the basic teaching of every religion; however, this knowledge should be customized based on the national or regional background and the right of the patient. The academia is responsible for the training and preparation of professional staff in the Halal field.
2. The responsibility of research centers: in Islamic counties, the research centers should be actively enrolled to verify this issue, as they have the required skills and facilities to analyze and study the nature of biomaterials. Furthermore, they should provide platforms for Halal research collaborations locally, regionally, and internationally to support Halal marketing.
3. The responsibility of governmental or national sectors and organizations: they need to closely collaborate and cooperate with the local universities to monitor the medical, pharmaceutical, cosmetic imported items. They are

also responsible to set guidelines for the international provider of healthcare and biomedical products on improving production and services for 'Halal' labeling, marketing, and monitoring. The author also suggests close collaboration between the available Halal certification bodies worldwide. There is a need for annual/biannual gatherings to set clear general criteria for Halal certification worldwide. Cooperation between these bodies can strongly advise international organizations to consider the importance of Halal biomaterials for the Muslim world.

4. The responsibility of social media: they are responsible to deliver sound and correct information to promote the Halal knowledge of the community and to educate them toward the available health product and their nature and the possible conflicts from the religious concern.

5. The responsibilities of international agencies: to help in defining guidelines regarding this issue in collaboration with regional and local agencies to fulfill medical ethics.

V. Conclusion

This paper shed light on the importance of the Halal issue in the consumption and application of pharmaceutical and biomedical materials which is frequently neglected. The impact of this issue should be evaluated from the perspective of medical ethics and patient consent and right. As such, the universities, the related governmental sectors, Halal institutes and certification bodies, Islamic organizations, and social media are responsible for setting the required criteria and policies regarding Halal marketing, labeling, and monitoring of biomaterials. It should be noted that this is the entire responsibility of the healthcare provider to be first familiar with the nature of the available biomaterials in the market and secondly to inform and consent the patient. Thus, education of both healthcare provider and patients are required.

References

[1]. Bergmann, C. P.; Stumpf, A. Biomaterials. In *Dental Ceramics: Microstructure, Properties and Degradation*; Springer Berlin Heidelberg: Berlin, Heidelberg, 2013; pp 9–13.

[2]. Williams, D. F. On the Nature of Biomaterials. *Biomaterials***2009**, *30* (30), 5897–5909.

[3]. M. Ebrahimi. Bone Grafting Substitutes in Dentistry: General Criteria for Proper Selection and Successful Application. *IOSR-J. Den. Med. Sci. 16***2017**, *16* (4), 75–79.

[4]. Ebrahimi, M. Biomaterials Application in Therapeutic and Regenerative Medicine From the Perspective of Patients' Faith. *Biomed. J. Sci. Tech. Res.***2018**, *8* (5), 1–3.

[5]. Quadri, S. F., Majeed, M., & Khan, M. What Is In Our Food? Is it permisssble? http://www.ifanca.org/Pages/staticwebpages.aspx?page=Whatisinourfood.

[6]. Blech, Z. Y. *Kosher Food Production*; Wiley-Blackwell: Oxford, UK, 2009.

[7]. Khandelwal, M. *Becoming American, Being Indian : An Immigrant Community in New York City*; Cornell University Press, 2002.

[8]. Gambhir, R.; Singh, S.; Kaur, A.; Nanda, T.; Kakar, H. Informed Consent: Corner Stone in Ethical Medical and Dental Practice. *J. Fam. Med. Prim. Care***2014**, *3* (1), 68.

[9]. Hall, D. E.; Prochazka, A. V.; Fink, A. S. Informed Consent for Clinical Treatment. *Can. Med. Assoc. J.***2012**, *184* (5), 533–540.

[10]. Samavedi, S.; Poindexter, L. K.; Van Dyke, M.; Goldstein, A. S. Synthetic Biomaterials for Regenerative Medicine Applications. In *Regenerative Medicine Applications in Organ Transplantation*; Elsevier, 2014; pp 81–99.

[11]. Nardo, T.; Carmagnola, I.; Ruini, F.; Caddeo, S.; Calzone, S.; Chiono, V.; Ciardelli, G. Synthetic Biomaterial for Regenerative Medicine Applications. In *Kidney Transplantation, Bioengineering and Regeneration*; Elsevier, 2017; pp 901–921.

[12]. Sheikh, Z.; Hamdan, N.; Ikeda, Y.; Grynpas, M.; Ganss, B.; Glogauer, M. Natural Graft Tissues and Synthetic Biomaterials for Periodontal and Alveolar Bone Reconstructive Applications: A Review. *Biomater. Res.***2017**, *21*, 9.

[13]. Bottino, M. C.; Thomas, V. Membranes for Periodontal Regeneration--A Materials Perspective. *Front. Oral Biol.***2015**, *17*, 90–100.

[14]. Shue, L.; Yufeng, Z.; Mony, U. Biomaterials for Periodontal Regeneration: A Review of Ceramics and Polymers. *Biomatter***2012**, *2* (4), 271–277.

[15]. Bostrom, M. P. G.; Seigerman, D. A. The Clinical Use of Allografts, Demineralized Bone Matrices, Synthetic Bone Graft Substitutes and Osteoinductive Growth Factors: A Survey Study. *HSS J.***2005**, *1* (1), 9–18.

[16]. Bauer, T. W.; Muschler, G. F. Bone Graft Materials. An Overview of the Basic Science. *Clin. Orthop. Relat. Res.***2000**, No. 371, 10–27.

[17]. Stewart, S.; Bryant, S. J.; Ahn, J.; Hankenson, K. D. Bone Regeneration. In *Translational Regenerative Medicine*; Elsevier, 2015; pp 313–333.

[18]. Shehadi, J. A.; Elzein, S. M. Review of Commercially Available Demineralized Bone Matrix Products for Spinal Fusions: A Selection Paradigm. *Surg. Neurol. Int.***2017**, *8*, 203.

[19]. Aziz, N. A.; Ibrahim, I.; Raof, N. A. The Need for Legal Intervention within the Halal Pharmaceutical Industry. *Procedia - Soc. Behav. Sci.***2014**, *121*, 124–132.

[20]. Gamradt, S. C.; Lieberman, J. R. Bone Graft for Revision Hip Arthroplasty: Biology and Future Applications. *Clin. Orthop. Relat. Res.***2003**, No. 417, 183–194.

Mehdi Ebrahimi. "The impact of patient faith on the selection of "permissible" biomaterials in pharmaceutical and biomedical fields."*IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 20(04), 2021, pp. 47-55.