Bioplastic Applications in Medicine Offer Great Promise for a Healthier Future

> *"Treat your body like a temple, not a woodshed. The mind and body work together. Your body needs to be a good support system for the mind and spirit. If you take good care of it, your body can take you wherever you want to go, with the power and strength and energy and vitality you will need to get there."*
> —Jim Rohn, Business Philosopher

Industry Spotlight: Will Expanded PHA Production Expedite Adoption of Bioplastics for Health Care Products?

By Laura Mauney

Research and development of bioplastic substances for medical, dental and pharmaceutical use have hovered on the front lines for years.

In some instances, products are already available, and are actively being used by pharmaceutical companies, field hospitals, trauma centers, surgeries, and clinics.

Gelatin-based capsules made of animal or vegetable matter, for example, which naturally dissolve in the digestive tract, are in common use to control dosages for many OTC (over-the-counter) and prescription medications.

Biodegradable stitches, which do not require manual removal after healing, are regularly used to suture wounds and surgical incisions.

Biodegradable bandages designed to promote clotting and proactive skin regeneration are also actively in use for traumatic wound care.

PHA Bioplastics Offer Great Adaptability Across a Range of Clinical Needs

MHG PHA Bioplastic is Durable, Biodegradable, and Adaptable to a wide Range of Medical and Pharmaceutical Applications.

The use of PHA bioplastics (polyhydroxyalkanoates) in healthcare delivery is an obvious and appealing direction that has stirred interest in the global medical community.

One reason PHA is being studied in medical product testing is that the biopolymers can be custom formulated for a range of tensile strengths, melting temperatures, and degradability timelines.

Unique advantages of using PHA bioplastics for health care delivery include:

- Biocompatibility
- Bio-absorption capabilities
- Inflammation reduction
- Interactive, biological support for cell regeneration and wound healing

The above features make PHA attractive for use in multiple medical, dental, and pharmaceutical applications, including cardiovascular and gastrointestinal care, oral tissue repair, chemotherapy and other drug delivery systems, orthopedic repair, and wound remediation.

Bioplastics can be Utilized by all Branches of the Health Care Industry

The impact of large-scale bioplastics production on medical, dental and pharmaceutical products can be projected along three distinct paths:

1. Medical Waste
2. Endoscopic Drug Delivery
3. Treatment and Healing

Medical Waste

In the arena of single use health care products and packaging, reducing the environmental impact of medical waste while eliminating passive transfer of toxins into tissue can be significantly addressed via the replacement of artificial plastics with biodegradable plastics.

Medical Waste can be dramatically Reduced by Replacing Artificial Plastics with Bioplastics in Common Clinical Products.

Millions of plastic gloves, packages, pill bottles, syringes, tubes, masks, and bandage covers are discarded in homes, clinics and at hospitals across the world every day. Much, if not most, of this waste came in direct contact with medicine, living beings, or both, during use.

Though the risk of toxic leaching from petrochemical plastic is low in these instances, it is not particularly desirable in a healthcare scenario. When the trash factor is added to the conversation, the argument in favor of using bioplastics for product packaging and therapeutic care products is strengthened.

Endoscopic Drug Delivery

Endoscopic (internal) drug delivery to inflamed areas and cancerous tumors via bioplastic carriers that degrade organically without a trace also offers huge promise.

Products in development or active use include drug eluting stents inserted to treat cardiovascular and gastrointestinal diseases, chemotherapy wafers implanted

Drug-Eluting Stents made of Bioplastic are being Tested as Replacements for Metal Stents in Cardiovascular and Gastrointestial Applications.

after tumor removal, prodrug delivery systems used to improve absorption of medicine, and targeted drug delivery via PHA nanoparticles.

Treatment and Healing

When the body's natural ability to regenerate cells needs to be assisted by patches, rods, bandages, and sutures, bioplastic products promise to reduce toxic risk to patients, and to enable more seamless healing and cell regeneration.

Use of bioplastic products on live subjects has overall resulted in a much lower risk of rejection, inflammation, excessive scar tissue, and future physical damage than that caused by products made of metal or artificial plastics.

Applications of bioplastics currently being tested or actively used in treatment and healing encompass these key target areas:

Bone Repair

Bioplastics with high tensile strength, including materials formulated with PHA, show great promise for orthopedic use.

Though not a suitable substance for joint replacement, bioplastics may one day replace metals and artificial plastics for other orthopedic mechanisms, including the rods, screws and pins often used to assist repair of broken bones.

Healed Bones that required Rods, Pins or Screws for Recovery Run a Lower Risk of Re-Fracturing if the implements are made of Degradable Bioplastics.

In instances of bone repair, the biodegradability factor is especially significant. Because bioplastics can be engineered to degrade at different speeds, rods implanted in broken bones can symbiotically degrade as bone cells are regenerated, with the rod completely disappearing by the time the damaged bone has reconstructed itself.

Solutions of this kind can eliminate altogether the need for surgical removal of implanted orthopedic devices, helping to avoid future risks such as re-fracturing.

Cardiovascular Care

Cardiovascular uses of bioplastics where biodegradability is acceptable have demonstrated lower inflammation and healthier cell regeneration.

Tests of Post-Surgical Patches, Scaffolds and Sutures made of Bioplastics have Shown Healthier Immune and Regenerative Response, with Less Scar Tissue.

In scenarios where natural tissue regeneration is the objective, such as closing surgical incisions, repairing heart defects, and promoting regeneration of arterial and vascular tissue, patches and scaffolds made of biodegradable plastics showed little or no inflammation, restenosis (recurrence of arterial or vascular constriction), or scar tissue production.

Potential cardiovascular uses of bioplastics also include stents and heart valves.

Tissue Regeneration

Bioplastic products that can be used to assist the body's natural ability to regenerate healthy cells during healing also include bandages, sutures, and gingival patches.

Highlights of research and development include biodegradable bandages designed to interact with the body's natural responses to wounds, to speed up clotting and skin cell production.

Additionally, because some wounds and incisions take longer to heal than others, biodegradable sutures can be constructed to degrade according to a specific time-frame for a specific level of healing.

Post-surgical biodegradable bandages and patches have also been developed to assist cell regeneration during repair of an internal injury, and to promote oral healing after dental surgery.

In all cases, one of the greatest advantages of biodegradable sutures and bandages is that they will breakdown organically over time, reducing, if not eliminating, the need for follow-up procedures.

As with all things Medical, Time and Testing is the Key

The long term effects of bioplastics in medicine will ideally create greater natural health for individuals by reducing, if not eliminating, tissue storage and buildup of toxic chemicals leached from artificial plastics.

In riskier areas of medicine, where biodegradability can cause problems if a bioplastic substance is used incorrectly, continued testing and ongoing evaluation is needed.

MHG's Chief Science Officer, Dr. Isao Noda, offers this cautionary tale about the use of bioplastics for

Though use of Bioplastics to make Endoscopic Chemotherapy Pic Lines needs further Testing, External Infusion Delivery Systems made of Bioplastics will Boost Healthy Treatment and Reduce Waste.

cardiovascular applications, for example:

> *"PHA is attractive because of the apparent bio-compatibility, but definitely not biodegradability. Biocompatibility means it does not irritate the tissues upon contact or does not cause clotting when exposed to blood. The material is accepted as a member of body parts, so to speak.*
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> *"Many people have the misconception that biodegradable implants, like stents, are a wonderful thing. In fact, if it starts degrading, it will kill you via massive stroke. PLA [polylactic acid] had issues due to degradation by spontaneous hydrolysis which caused tissue irritation by the degradation product of lactic acid.*
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> *"Fortunately, PHA seems very stable in your body, as long as it is not exposed to degrading enzymes or bacteria. Your blood stream is devoid of bacteria, if you are healthy. That is why you can make very stable artificial heart valve out of PHA which will not degrade."*

To learn more about how MHG's PHA can be safely biodegraded as medical waste more healthfully and cost-effectively than petrochemical plastics, read Isao Noda's article about **Hot Alkaline Digestion of NODAX™ PHA** (http://www.mhgbio.com/hot-alkaline-digestion-of-nodax-pha/).

For more comprehensive information about scientific developments and studies of the use of biodegradable plastics in health care products, including PHA, please visit the National Center for Biotechnology Information website (http://www.ncbi.nlm.nih.gov), which contains a full library of papers and other resources related to PHA research, and uses of biotechnology in medicine.

Does your Company Manufacture or Package Medical Products?

*Please visit **MHGBio.com** (http://www.mhgbio.com/), to find out more about how biodegradable plastics from MHG can be adapted to a wide range of product manufacturing and packaging requirements.*

***Learn more** (http://www.mhgbio.com/mhg-sustainability/mhg-certifications/) about how MHG's biodegradable PHA plastic is **Certified** (http://www.mhgbio.com/mhg-sustainability/mhg-certifications/) for all six levels of biodegradability and compostability.*