3D Printing in Medicinal Chemistry: Applications, Prospective and Consideration

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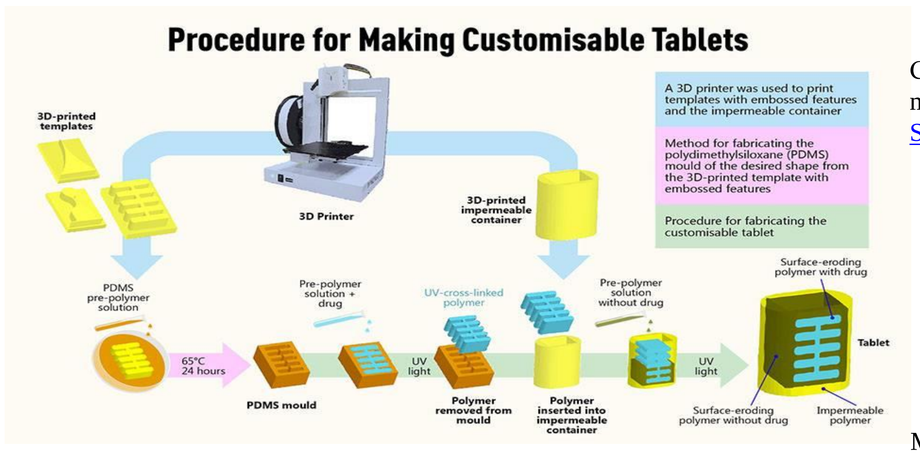
Introduction

- 3D Printing is defined by (ISO) as: “fabrication of objects through the deposition of a material using a print head, nozzle, or another printer technology” and has drawn great intrigue in the field of medicine, among others.
- Implementation of 3D printing could provide organic chemists a safer workplace by decreasing noxious exposures.
- A further advancement in personalized medicine via the customizable features that 3D printed materials provide, such as dosage forms to fit a certain pharmacokinetic profile and individualized transplants.
- Web of Science Core Collection papers containing the term 3D print increased from 0 to 77 from 2012 to 2017 increasing the number of citations from 209 to 12411 respectively. In 2017, 77 records relevant to pharmacy/pharmacology were noted indicating a shift in interest in the field.
- The FDA has stated its interest in 3D printed drugs as a flexible solution for medications that target small populations and, if adopted in advanced manufacturing, could 60 billion dollars per year for the United States, mostly in manufacture costs.[1]
- The FDA approved a 3D printed tablet for the first time in 2015.

Purpose

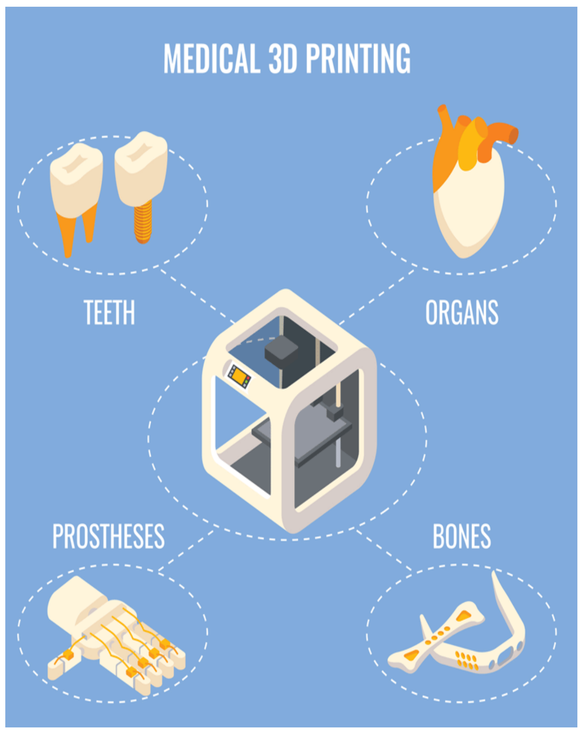
The purpose of this poster is to provide an overview of the current and prospective applications and of the debatable aspects of the intersection between 3D Printing and MC.



Customizable tablets’ making procedure, Source

Methods

This is a literature study. We searched medical (Pubmed, Google Scholar) and tech (InTech) databases with key words (3D Printing, Medicinal Chemistry, considerations). We included studies authored in English or Greek and excluded studies with considerable conflict of interest.



Medical 3D Printing, Source

3D Printing Medical and Pharmaceutical Modalities, Source

Results

The biomedical applications of 3D printing can be categorized into:

- 3D-printed medical devices:
  - Wound dressings
  - Patient-specific antimicrobial wound dressings
  - Scaffolds for wound healing in vascular grafts that can support the replacement of injured vessel wound after surgical reconstruction
  - Implants and Prostheses
  - Prosthetic limbs
  - Facial implants
  - Implantable medical devices, such as stents and laparoscopic trocars
  - Models for Surgical Planning and Training
  - Organs, such as liver, kidney and heart models
  - Tumor models
  - Disease models, such as brain models of Alzheimer’s disease

- Bio-inspired, bio-based 3D printing:
  - Bioprinting and Organs-on-Chip
  - 4th Dimension of Printing: smart 3D-printed materials that can change their shape and properties upon external stimuli over time, such as hydrogels that can release a drug upon thermal trigger at the first stage of inflammation.
  - Biorobotics: bio-inspired hybrid devices that can mimic various biological functions

- 3D-printed drugs
  - tablets manufactured through 3D printing, approved by the FDA
  - 3D printing of five-in-one dose combination polypill with defined immediate and sustained release profiles.

Discussion

In the future the following breakthroughs are expected to appear grace to the 3D Printing – Medicinal Chemistry interference

- Customized Drug Treatments
- Polypills: one pill containing multiple drugs
- 3D-printed grafts with integrated vasculature
- Discussion
- The use of 3D printing into the pharmaceutical industry can bring upon several advantages, such as cost efficiency, customisation and environment welfare.
- 3D printing provides with the opportunity to manufacture medicine cheaply, as it decreases the utilisation of unnecessary resources, contrary to the conventional technique of drug production.
- It is considered to be a much faster, accurate and reliable approach, since it involves scanning and polishing processes instead of mixing, molding and compression.
- It gives the ability to create customised drugs, drugs with complex geometries and drugs in short supply, difficult to be fabricated in big industries.
- 3D printing is environment friendly, since it does not demand a complex manufacture system in order to be beneficial.
- It could also be a tool of translation of research, since it gives immediate results.
- It could also benefit the fabrication of medicine on space missions, due to its accuracy.

References

- Scammell, R. (2019, August 12). FDA prioritises 3D printed drugs with $58m backing. Retrieved October 29, 2019, from https://www.verdict.co.uk/fda-prioritises-3d-printed-drugs/.
- Notman, N. (2018, April 27). 3D printing in pharma. Retrieved October 29, 2019, from https://www.chemistryworld.com/features/3d-printing-in-pharma/3008804.article.
- Witkowski JS, Pędziwiatr M, Major P, Budzyński A. Cost-effec- tive, personalized, 3D-printed liver model for preoperative plan- ning before laparoscopic liver hemihepatectomy for colorectal cancer metastases. Int J Comput Assist Radiol Surg. 2017;12(12):2047–54.
- Zuniga J, Katsavelis D, Peck J, Stollberg J, Petrykowski M, Carson A, et al. Cyborg beast: a low-cost 3d-printed prosthetic hand for children with upper-limb differences. BMC Res Notes. 2015;8:10.
- He Y, Xue G, Fu J. Fabrication of low cost soft tissue prostheses with the desktop 3D printer. Sci Rep. 2014;4:6973.
- Shaban A. Khaled, Jonathan C. Burley, Morgan R. Alexander, Jing Yang, Clive J. Roberts, 3D printing of five-in-one dose combination polypill with defined immediate and sustained release profiles,Journal of Controlled Release, 217, 2015, Pp308-314