Journal of Interdisciplinary Science Topics

Life in Plastic … Is it getting 2 Fantastic?

Uatii R. Hengari
Natural Sciences (Life and Physical Sciences), School of Biological Sciences, University of Leicester
25/04/2023

Abstract
"*I'm a barbie girl, in a barbie world – life in plastic. It's fantastic*." Or is it getting more drastic – drastically detrimental to the wellbeing of a person? This paper is a sequel to the paper "Life in Plastic … Is it fantastic?" where skin and cells in organs were considered as being composed of Plastic. Precisely, plastic found in Barbie dolls. In this paper 44% of the body is explored as composed of plastic, collagen (30%) and bones (14%). This is all based off Barbie dolls and the song by Aqua.

Keywords: *Song; Biology; Plastic; Collagen; Bones; Aqua; Barbie*

Introduction
Barbie is a fictional character who lives a 'fantastic' life and has attributed part of her success in life to life being 'in plastic', according to the song Barbie Girl by Aqua. This paper builds on from the work conducted in the paper 'Life in Plastic … Is it fantastic?' [1] In all fairness this is not an original claim by Barbie, and it is a known fact that Mattel filed a lawsuit against Aqua over the song [2]. Nonetheless, when a person characterises themselves as a 'Barbie Girl' it is an almost instinctual reaction to continue forwards by placing themselves in a 'Barbie World' according to the song. Despite efforts by Mattel, the song remains a classic amassing a grand total of over 1.1 billion views on YouTube since being released 12 years ago (from 2023) [3]. This paper explores key components of the body to further attempt to explore how much more of the body can be made with plastic to truly assess whether life in plastic could be fantastic. Previous relevant research has already proven that the proportions of Barbie's body would not be fantastic and would result in the individual walking on all fours [4]. Contrarily, we are only looking at how a person could look like Barbie by being made of plastic so they would have similar texture and characteristics, to her as a result of having the same materials as her so they would probably be lighter and be able to walk even if they had her proportions. This is the sequel. The initial paper indicated that more than 15% [1] of a person could be fantastic in plastic by replacing their skin, the largest organ [5], with plastic. Through considering some other internal organ mass (by utilising plastic petri dishes) this value would increase to 17% but this was bordering on fantastical as many of the organs considered grown in petri dishes had not even had an experience inside the human body, let alone in nano petri dishes inside the human body [1]. This paper will consider more of the human body's composition by looking at collagen and bones. But is this too fantastic? Is this … drastic?

Figure 1 – Snapshots from the music video of the Barbie girl song by Aqua displaying Ken inviting Barbie to party and the party later that evening [3].

Collagen Replacement

Collagen is considered a biological plastic and is the most abundant protein in the body. It comprises about 30% (dry weight) of the human body [7]. Tropocollagen is a type of collagen which is made up of three polypeptide chains and the whole molecule has a molecular weight of about 300,000 g mol^{-1} meaning each subunit peptide has a molecular weight of about 100,000 g mol^{-1} [8]. When collagen is denatured, it loses its triple-helical structure, and the polypeptide chains arrange themselves in a random configuration [8]. This occurs at temperatures of about 40 degrees Celsius [8]. There are 5 main types of collagens from type I to type V [9] whilst there are 28 types [9]. They are found all over the body from layers of the skin, in bones, muscles and in arteries and organs. Collagen has a Youngs modulus of between 46.5 ± 19.4 and 35.2 ± 27.0 MPa [10] which is within the range of the values for the Barbie plastics [1]. This suggests that potentially all the collagen can be replaced with plastic as its function is mainly structural and will be able to support and look after the organs of the body. The previous evidence indicates that barbie plastic would be able to replicate the some of the functions of collagen the 'bioplastic' adequately. Another key function of collagen is its role as a blood clotting agent [9]. Collagen is involved in helping your blood to clot [9] by attracting platelets to the site of injury when the blood vessel is injured [11]. Researchers have discovered plastics that are essentially 'self-healing' suggesting that the plastic could be assembled in a way to promote clotting similar to collagen [12].

Barbie Bones

Bone accounts for 14% of the human body weight [13]. The materials listed in the Barbie materials are not the most ideal synthetic material. Typically polyetheretherketone (PEEK) is the most compatible plastic with the human body, has the qualities required for bearing loads, and it is the most used in reconstructive surgeries [14]. The polymeric ternary blend has capabilities for enhancing skeletal regeneration [14]. Some of the plastics involved in the barbie materials are capable of being used for bones. This is validated by their role in, for example, bone tissue engineering' [14]. PEOT/PBT and nanosilicates have a synergistic ability which can be used in the creation of bioactive scaffolds [15]. EVA in a protective role has also been shown to absorb and dissipate energy from impact that would otherwise fracture nasal bone [16].

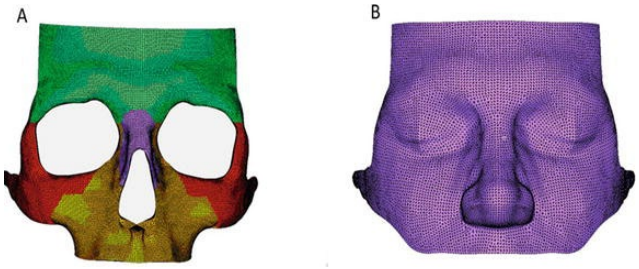

Figure 2 – A CT image of the bone(A) and soft tissue(B) of the face [16].

Conclusion

In this paper it has been shown that collagen could be replaced with the Barbie materials and bone can also be replaced with plastic which is not purely Barbie materials. However, as skin contains about 80% [17] collagen, we will consider the results of this exploration in isolation to the initial paper and then calculate an approximate final composition of the body parts across both papers. Cells in this case shall be excluded as nano-petri dishes are not composed of Barbie materials and the process seemed the least plausible. Bones could be replaced with plastic so we will consider that there is a chance to make a special composition of the Barbie materials with similar properties to the PEOT/PBT and PEEK. We find that 44% of the body can be composed of Plastic considering only bone replacement and collagen replacement. However, as the bones would not include stem cells this means the plastic person would not be capable of growth or reproduction which are both important factors of life. Including the percentage of skin calculated from the first paper and factoring the overlap between collagen content in the skin we can say approximately 47% of the human body can be replaced with plastic. Fantastically? Well, it is likely that the plastic person would have frequent visits to the hospital due to issues of sealing minor injury, degradation of material, infection and possible rejection of the materials by the body [1]. Even though they have the physical capabilities (mechanical functionality) to have fun and party, based on the drawbacks we should leave being fantastic in plastic up to Barbie.

References

[1] Hengari, U.R. (2023) *'Life In Plastic…Is It Fantastic?'* Journal of Interdisciplinary Science Topics vol.10. https://journals.le.ac.uk/ojs1/index.php/jist/article/view/4367 [Accessed 24th April 2023]

[2] Wikipedia (2023) *Barbie Girl*. [online] Available at: https://en.wikipedia.org/wiki/Barbie_Girl [Accessed 17th March 2023].

[3] AquaVEVO (2010) *Aqua - Barbie Girl*. *YouTube*. Available at: https://www.youtube.com/watch?v=ZyhrYis509A. [Accessed 17th March 2023]

[4] Maine, M. (2006) *"Get Real Barbie" Fact Sheet*. Adapted from Body Wars, Margo Maine, Gurze Books, 2000. [Online] Available at: https://www.chapman.edu/students/health-and-safety/psychological-counseling/_files/eating-disorder-files/13-barbie-facts.pdf [Accessed 17th March 2023]

[5] Swann, G. (2010) *The Skin Is the Body's Largest Organ*. Journal of Visual Communication in Medicine, 33(4), pp.148–149. DOI: 10.3109/17453054.2010.525439

[6] History.com Editors (2019). *The Barbie doll makes its debut*. [online] HISTORY. Available at: https://www.history.com/this-day-in-history/barbie-makes-her-debut [Accessed 17th March 2023]

[7] Deshmukh, S.N., Dive, A.M., Moharil, R. & Munde, P. (2016) *Enigmatic insight into collagen*. Journal of Oral and Maxillofacial Pathology: JOMFP, 20(2), pp.276–283. DOI: 10.4103/0973-029X.185932.

[8] Stenzel, K.H., Miyata, T. & Rubin, A.L. (1975) *Collagen: A Biological Plastic*. Polymers in Medicine and Surgery, 8, pp.109–118. DOI: 10.1007/978-1-4684-7744-3_8.

[9] Cleveland Clinic (2022) *Collagen: What it is, Types, Function & Benefits*. [online] Cleveland Clinic. Available at: https://my.clevelandclinic.org/health/articles/23089-collagen [Accessed 15th March 2023].

[10] Manssor, N.A.S., Radzi, Z., Yahya, N.A., Mohamad Yusof, L., Hariri, F., Khairuddin, N.H., Abu Kasim, N.H. & Czernuszka, J.T. (2016) *Characteristics and Young's Modulus of Collagen Fibrils from Expanded Skin Using Anisotropic Controlled Rate Self-Inflating Tissue Expander*. Skin Pharmacology and Physiology, 29(2), pp.55–62. DOI: 10.1159/000431328.

[11] Farndale, R. (2015) *How collagen helps the blood to clot*. [online] Bhf.org.uk. Available at: https://www.bhf.org.uk/research-projects/collagenlike-peptides-synthetic-tools-to-investigate-vascular-cell-function [Accessed 17th March 2023]

[12] Xing, X., Li, L., Wang, T., Ding, Y., Liu, G. & Zhang, G. (2014) *A self-healing polymeric material: from gel to plastic.* Journal of Materials Chemistry A, 2(29), p.11049. DOI: 10.1039/c4ta02079k.

[13] Krajewski, B. (2019) *Human Bones, Joints and Muscles Facts:* [online] Winston Medical Center. Available at: https://www.winstonmedical.org/human-bones-joints-and-muscles-facts [Accessed 15th March 2023].

[14] Liao, C., Li, Y. & Tjong, S.C. (2020) *Polyetheretherketone and Its Composites for Bone Replacement and Regeneration*. Polymers, 12(12), p.2858. DOI: 10.3390/polym12122858

[15] Carrow, J.K., Di Luca, A., Dolatshahi-Pirouz, A., Moroni, L. & Gaharwar, A.K. (2018) *3D-printed bioactive scaffolds from nanosilicates and PEOT/PBT for bone tissue engineering*. Regenerative Biomaterials, [online] 6(1), pp.29–37. DOI: 10.1093/rb/rby024

[16] Dias, R.B. e, Coto, N.P., Driemeier, G.F.B. & Driemeier, L. (2018) *Systematic Study of Ethylene-Vinyl Acetate (EVA) in the Manufacturing of Protector Devices for the Orofacial System*. Biomaterials in Regenerative Medicine. www.intechopen.com. IntechOpen. DOI: 10.5772/intechopen.69969

[17] Oikarinen, A. (1994) *Aging of the skin connective tissue: how to measure the biochemical and mechanical properties of aging dermis.* Photodermatology, Photoimmunology & Photomedicine, [online] 10(2), pp.47–52. PMID: 8043384. Available at: https://pubmed.ncbi.nlm.nih.gov/8043384 [Accessed 15th March 2023].