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How the Black Panther Serum Works

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Abstract

This paper provides context behind how the Black Panther serum seen in both Black Panther movies, provided such enhanced abilities. The Black Panther serum is a heart shaped herb containing a metallic ore called Vibranium. This paper explores the possibility that this metallic ore may have been absorbed into the heart shaped herb, by the same mechanism as cadmium via the apoplast and symplast pathway. Through ionising radiation vibranium then mutated the herbs genome. These mutations in the heart shaped herb are transferred via Eukaryotic gene transfer into Black Panthers genes. These gained mutations which give Black Panther a range of enhanced abilities.

Keywords: *Film; Biology; Gene transfer; Vibranium; Heart shaped herb; Black Panther*

Introduction

The Marvel superhero Black Panther ingests a heart shaped herb (see figure 1) which is a native plant to Wakanda [1]. This heart shaped herb is taken as a serum which gives Black Panther enhanced strength, instinctive awareness, super speed, resilience, and many other enhanced physical abilities [2]. The heart shaped herbs were created a million years ago as a result of a meteorite crashing into Wakanda, this meteorite was composed of Vibranium [2]. The large amounts of radiation emitted from the meteorite affected the plant life in Wakanda [2]. The vibranium was absorbed into the plants providing it with the facilities to give enhanced abilities.



Figure 1 – A woman holding the heart shaped herb in her hands [2].

This paper will investigate how vibranium is absorbed by the plant life in Wakanda producing the Black Panther serum. How this serum enters Black Panther's genome through horizontal gene transfer and causes mutations providing black panther with enhanced abilities.

Plants absorption pathway of heavy metals

Vibranium is a metallic ore present in the soil and therefore can be absorbed in the same way as a heavy metal into the heart shaped herb. The absorption pathway of the heavy metal cadmium could potentially be applied to Vibranium. Vibranium can be transported through the heart shaped herb via the apoplast and symplast pathway in the same way as cadmium [3]. The apoplast pathway involves transportation from root hair to xylem via the cell walls. The symplast pathway involves transportation through plasmodesmata region in the cells.

Vibranium would initially be retained in the roots and translocated to the shoots in small amounts [3]. When Vibranium enters the herb, it can enter the root via two pathways [3]:

- 1) Absorbed hydrogen exchange with the heavy metal at the plasma membrane of the root epidermal cells this is via the apoplast pathway [3].
- 2) Enter the plant via other ion channels combining with there transport proteins entering the root epidermal cells via the symplast pathway [3].

Vibranium then travels from the root surface where they are sequestered inside root cells and move through apoplasmic barriers [3]. Entering the symplast and being transported to the stele. Then

loaded into the xylem vessel via membrane transport proteins, ready for transportation into the stem [3]. When the vibranium reaches the leaf tissue the metal is sequestered into the extracellular and subcellular compartments and deposited into various cell types in the leaf tissue [3].

Vibranium can produce ionising radiation to cells in the herb. Ionising radiation is a form of energy that removes atoms or molecules, and the loss of these electrons causes excitation of these atoms or molecules as they become positively charged [4]. The intermolecular or intramolecular transfer of energy leads to the formation of free radicals [5]. These free radicals react with the DNA of the plant cell causing damage most commonly double stranded breaks which during repair leads to mutations [5, 6]. These mutations are expressed in the DNA of the plant cells, which is how the vibranium causes mutations in the plants genome which is passed onto Black Panther's genome.

Horizontal gene transfer

Endosymbiosis is a form of horizontal gene transfer. Through this transfer organelles such as mitochondria and plastids have been derived in evolution allowing for genes to be moved between eukaryotes. We will be focussing on endosymbiotic gene transfer of mitochondria and plastids which originates from alpha-proteobacterium and a cyanobacterium respectively [7]. There is a continued gene transfer of these organelles through evolution however, this process does need to be better understood [7]. This could potentially be applied to eukaryotic gene transfer between the heart shaped herb and Black Panther. The plastid genes were transferred from endosymbiont nucleus to the host nucleus [7]. This repeated gene transfer can result in there being an uneven distribution of genes across the acceptor organelle genome [7]. This is predominantly seen in plant plastids and mitochondria. Numerous nuclear genomes contain organelle derived sequence which establishes the idea that the nuclear genome can take up and adopt foreign DNA [7]. Additionally, there is the first known natural gene transfer from a plant to *Whitefly Bemisia tabaci* an insect which occurred many years ago [8]. The gene integrated into the insects genome neutralises a toxin produced by plants to defend against plant pests [8]. These both show example of eukaryotic gene transfer which could be used as potential mechanisms for the mutations in the herbs

genome to be transferred to Black Panther's genome and provide him with enhanced abilities.

Mutations in the genome

The heart shaped herb genetic mutations are transferred to Black Panther's genome leading to enhanced abilities. As mentioned prior some of these enhanced abilities include super strength, super speed, resilience, agility and many more [2]. We will be looking into the changes that had to have occurred in Black Panther's genomes to allow for these enhanced abilities. Myosin related muscle hypertrophy indicates that an individual has reduced muscle fat and increased muscle size [9]. Therefore, these individuals contain twice the usual amount of muscle mass in their bodies [9]. This can lead to enhanced strength in an individual in this case Black Panther due to such a high muscle mass. It is caused by mutations in the MSTN gene as this gene provides the instruction for making myostatin, a protein which is active in skeletal muscles which are the muscles used for movement [9]. The protein MSTN regulates muscle growth to ensure they don't grow too large. Therefore, gaining this mutation leads to reduced functional myostatin production causing an overgrowth of muscle tissue [9]. Allows muscles cells to divide more which increase muscle mass [10].

Black Panther also had super speed which can be caused by fast twitch muscle fibres having the ability to contract at a rapid rate and provides a burst of force aiding in sprinting [10]. The alpha actinin-3 protein encoded by ACTN3 gene which is in skeletal muscle cells aid in making, stabilising fast twitch muscle fibres, and breaking down glycogen which can be converted into glucose and other energy containing compounds for the muscles [10]. In an average individual alpha actinin-3 protein is non-functional [10]. Due to vibranium Black Panther could have a mutation in this gene which means this protein is functional and therefore enhances both his speed and power.

Conclusion

To conclude it is plausible that the serum could cause such enhanced abilities. Upon absorption vibranium causes mutations in the heart shaped herb's genome facilitated by ionising radiation. The mutations in the plant genome could then undergo gene transfer to the Black Panther via the apoplast and symplast pathways. This DNA insertion causes mutations in the genome specifically MSTN and ACTN3 gene enhancing Black Panther's abilities.

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