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Culture and Values

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Popular Culture and Genetics: Genetics and Biotechnologies in the Movies

Abstract: Although the past few decades have been marked by a rapid development of biotechnologies, it significantly precedes the social understanding of genetic phenomena. At the same time, as biotechnologies have become an object of public interest, popular culture, particularly movies, plays an increasingly important role in shaping the public attitudes towards biotechnologies. Thus, by stressing the impact of popular culture on the social understanding of science, this paper aims to describe the dominant genetic tropes portrayed in the cinema. By analysing 175 movies that relate to biotechnologies produced between 1953 and 2018, it analyses seven main themes: 1) the general image of genetics, 2) genetic procedures 3) mutations, 4) DNA, 5) genetic essentialism, 6) the nature versus nurture debate, and 7) biofears generated in the movies.

Keywords: biotechnology, cinema, genetics, movies, popular culture, science fiction.

Introduction

Although the past few decades have been marked by a rapid development of biotechnologies, it significantly precedes the social understanding of genetic phenomena. Consequently, the public express ambivalent attitudes towards biotechnologies (Priest 2000; Eurobarometer 2010). Simultaneously, as genetics generates a huge social interest, it functions as a unique object of the collective imagination (Domaradzki 2016, 2018). In fact, biology itself does not explain the social fascination with genetics. On the contrary, while its social perception is influenced by consecutive scientific discoveries, in a large part, genetics owes its renown to popular culture, which invokes many myths, beliefs and ideas on scientific issues (Handlin 1965; Turney 1998; van Dijck 1998; Nelkin and Lindee 1999; Bates 2005; Roberts et al. 2019). Consequently, the social communication of science is not a linear process. Since lay knowledge about scientific topics is much more complex and advanced than it is assumed by the experts, the public are not a passive recipient of a scientific message but actively participate in the social construction of meanings ascribed to genetics. Indeed, individuals who face biotechnologies already possess specific knowledge, ideas and opinions about genetics, which are influenced by their personal and social experiences which shape their understanding of biotechnologies.

Simultaneously, as biotechnologies have become an object of public interest, popular culture, including the cinema, plays an increasingly important role in the popularization of science. This is not surprising because while many individuals gain their knowledge

from formal education and scientific sources, the majority learn about science from popular culture. Moreover, although most people do not know the basic principles and mechanisms of modern genetics nor have they read any fundamental work on genetics, they have seen such cinematic productions as: *Jurassic Park*, *The Island of Dr. Moreau* or *The Island*; or have read such novels as: Huxley's *Brave New World*, Levin's *The Boys from Brazil*, Cook's *Mutation* or *Marker*, Clement's *Mutant* or Marc Elsberg's *Helix*. Thus, while popular culture is often seen as an inferior part of culture and some downplay its impact on the social understanding of science, it constitutes an important forum for discussion on the social impact of such new technologies as cloning (Cormick 2006; O'Riordan 2008; Haran et al. 2008; Eberl 2010), neurotechnologies (Krahn, Fenton and Meynell 2010) or synthetic biology (Meyer, Cserer and Schmidt 2013). Significantly, genetics is currently one of the most popular sciences represented in films, and while it is a relatively young science, it has been permanently inscribed into the history of the cinema (Wood 2002; Glassy 2006). This is important because movies reach a much wider segment of society and a single cinematic picture may have a bigger impact on social attitudes towards science than formal education (Muela and Abril 2014).

What is equally important is that while the media often report on the latest scientific discoveries, the cinema is primarily focused on asking questions regarding the social and ethical consequences of biotechnological progress (Meyer, Cserer and Schmidt 2013). Moreover, in contrast to the other media which usually create an overly positive image of biotechnologies, movies question such an optimistic picture. For this reason, Daniel Dinello (2005: 8) writes about a unique technophobia defined as: "aversion to, dislike of, or suspicion of technology rather than an irrational, illogical, or neurotic fear." He argues that it results from the fact that the cinema addresses a wide spectrum of fears related to genetics, i.e. human cloning, eugenics, genetic discrimination, the militarization and commercialization of biotechnologies, commodification of the body, safety of genetically modified organisms and lack of social control over genetic experiments. Thus, by expressing social anxieties related to the uncontrolled expansion of biotechnologies, rather than creating alternative visions of biotechnologies the cinema creates a space for the contestation of science (Hamilton 2003: 276). Simultaneously, while being the medium by which individuals experience the biotechnological revolution, the cinema also enables its interpretation. This is because while attaching meanings to biotechnologies the public use their own language, which does not refer to numbers, scales and charts, and it is popular culture that serves as a particular type of "filter" which helps the public experience the reality and absorb the scientific information. Thus, this paper aims to analyze the dominant genetic tropes portrayed in the cinema.

Material and Methods

All in all, 175 movies have been analyzed (Appendix 1). The sample covers the period from 1953, when the structure of the double helix was announced, until 2018, inclusively. The sample was designed according to a content-based criteria. While it contains movies from all genres: science fiction, horror, drama, thriller, adventure, action, comedy, etc., films

were included only if the story covered genetics or biotechnologies. For the selection of the movies a search was conducted in two online movie databases: Internet Movie Database (http://www.imdb.com) and Filmweb (http://www.filmweb.pl). Then the available plot descriptions were compared with predefined key words: "genetics," "biotechnology," "genetic engineering," "cloning," "DNA," "mutation," "mutant," "genetic modifications."

To provide more homogenous results, television series, both with a medical theme, i.e. *Doctor House*, science fiction, i.e.: *Aeron Flux*, *The Outer Limits*, *Orphan Black*, and animations: *Clone High*, *Neon Genesis Evangelion*, were excluded. Also, movies on rare genetic disorders, such as: *Lorenzo's Oil*, *Paa*, *Imagine* or *Everything, Everything* were omitted. While especially the latter type of movies would add some diversity to the genres, they have been disregarded because most of these movies do not focus on biotechnology itself but rather on the psychosocial problems of patients with rare diseases, a topic that is much beyond the scope of this research. Thus, unless the movie discussed genetic therapy it was not included into the analyzes. Also movies addressing mutations caused by radiation and/or chemical substances, i.e. *Frogs*, *Alligator*, *Mansquito* or *Fantastic Four* were not taken into consideration. Similarly, films where genetics was only mentioned but was not developed, i.e. *28 Days Later*, *Minority Report* or *28 Weeks Later* were also omitted. Although also these pictures could add something into the discussion about biotechnology, this research was limited only to movies where biotechnologies were the main theme. Finally, movies where human cloning is caused by cosmic forces and does not relate to genetics, such as: *Solaris*, *Invasion of the Body Snatchers*, *Starman* and *Body Snatchers* were also omitted.

At the same time, I am aware that because the entire number of movies picturing genetics and biotechnologies cannot be adequately determined the selection of films neither is nor could be representative. Another limitation is that the vast majority of analysed movies were either produced in the United States (67.8%) or in cooperation between the United States and European or Asian countries (19.7%) while only 2.8% were shot in Canada, 2.2% apiece in the UK and Japan, 1.1% in South Korea, and single movies were produced in Germany, Italy, France, Hong Kong and New Zealand. Thus, the study sample is somehow biased as it under-represents European, Asian and Hispanic cinema. However, it is undeniable that the American film industry has a dominating power on the global movie market and its impact on popular culture and the global audiences is distinctive (Segrave 1997; De Zoysa and Newman 2002). Thus, to make sure that the selected movies reached a wider audience both their US and international box office have been checked (http://www.boxofficemojo.com), which, at least to some degree, reflects the scale of their reception.

The movies retrieved were studied using a sociological film interpretation (Darbyshire and Baker 2012; Bergesen 2016; Nascimento 2019). A qualitative content analysis was designed to identify recurring patterns in the portrayal of genetics and biotechnologies. Movies were analysed using a thematic analysis (Guest, MacQueen and Namey 2012). It involved a six-step process, starting with familiarisation with the data which involved re-watching all the movies. After becoming immersed with its content, initial succinct codes were generated which helped to identify important features present in films. After all the movies were coded, all the data was collated into groups identified by code what allowed to generate initial themes. Next, these candidate themes were compared and checked against the dataset which helped to determine that the themes were useful and accurately represented the data

depicted in the movies. When the final list of themes was created, a detailed analysis of each theme was developed and the 'story' of each theme was determined. Finally, they were defined, named and written-up (Braun and Clarke 2006; Nowell et al. 2017).

The study results were selected by employing an inductive approach and classified as thematic categories. While some research focused on a particular type of biotechnology or theme, my intention was to provide a review of the variety of genetic tropes portrayed in the cinema. To achieve that, the quantitative analysis of the movies selected for the study was designed to identify recurring patterns in the images of genetics and biotechnologies. The most frequently appearing themes identified, selected and analyzed were: 1) the general image of genetics, 2) genetic procedures 3) mutations, 4) DNA, 5) genetic essentialism, 6) the nature versus nurture debate, and 7) biofears generated in the movies. Nevertheless, not all the movies covered all these categories. Thus, although this paper focuses on a qualitative approach, I believe that it shows how movies reflect and construct social ideas about genetics and biotechnology. Moreover, as it aims to analyze the cultural meanings attached to genetics, the selected categories provide a unique insight into the cinematic images of genetics that can be easily recognized by the public.

Results

Although genetics and biotechnologies appear in all genres they are disproportionately popular in horror (34.5%) and action movies (35%) (Table 1.). Less frequently, they are covered in dramas (11.5%), comedies (7.5%), thrillers (5.7%) and adventure movies (5.2%). Only one animation addressed such topics (0.6%).

Table 1

Movies by genre

Genre	N	%
Horror	60	34.5
Drama	21	11.5
Thriller	10	5.7
Adventure	9	5.2
Action	61	35.0
Comedy	13	7.5
Animation	1	0.6
Total	175	100.0

While in the fifties and the sixties genetics appeared only in three movies (1.8%), in the next two decades it was 8.1% and 9.8%, respectively (Table 2.). The highest interest in biotechnology was observed between 2000–2009 (a decade when the completion of the sequencing of the human genome was announced), when over one third of all the movies were produced (35.8%). Another 25.4% of films were made in the nineties, when the Human Genome project was initiated. Although currently more and more movies focus on neurosciences and neurotechnologies, between 2010–2018 another 19.1% of films dealing with biotechnologies were released.

Table 2

Movies by decades

	N	%
1950–1959	2	1.2
1960–1969	1	0.6
1970–1979	14	8.1
1980–1989	17	9.8
1990–1999	44	25.4
2000–2009	62	35.8
2010–2018	35	19.1
Total	175	100.0

At the same time, while across the decades genetics and biotechnologies appear in various type of genre, some interesting relation between the production year and the movie genre has been found. Firstly, horrors resulting from genetic engineering were especially, although not exclusively, popular in the seventies and the eighties (*She Demons*, *Night of the Lepus*, *The Mutations*, *Prophecy*, *Island of the Fishmen*, *Humanoids from the Deep*, *The Unborn*, *The Nest*). It resulted from the fact that in the late 1970s scientists had learned to use restriction enzymes to cut DNA molecules at specific sites to produce linear segments of DNA. This in turn, led to a controversy surrounding the experiments using recombinant DNA and provoked the discussion on the possible health and environmental hazards of this novel genetic technique. Secondly, further development of genetics which resulted in the possibility of using biotechnologies for political, military or commercial purposes resulted in that moviemakers often stressed that genetics shifted from a purely academic enterprise to political/military/industry-oriented/dependent business, a topic popular in many action movies produced the eighties and the nineties *(Universal Soldier*, *Judge Dredd*, *The X-Files: Fight the Future*, *Replicant*, *Jurassic Park*, *The Lost World: Jurassic Park*, *Deep Blue Sea*). Finally, because ever since the Human Genome Project had been initiated, it was accompanied by the ongoing debate on its ethical, legal and social implications (ELSI), and biotechnologies stared to appear also in dramas and thrillers which were particularly popular at the turn of the century (*Gattaca*, *Brave New World*, *Blueprint*, *Code 46*, *Godsend*, *Moon*, *Womb, A number*, *Never Let Me Go*). Thus, while each movie consists of different actions, social groups, objects, emotions and scenes that help the moviemakers to focus the audience's attention, it seems that movie gernes are cultural categories which have a palpable impact on social perception of genetics and biotechnologies. Moreover, they constitute a key source for articulating basic human perceptions, emotions, including hopes and anxieties, cognitions and actions (Tudor 1974; Mittell 2004). Cinema's preoccupation with biotechnologies is further exemplified by a wide spectrum of their applications presented in the movies (Table 3.). Most frequently, the cinema pictures (human) cloning, which is present in 32% of all the movies. 10.7% of these films show how cloning can be used for the creation or replication of (ideal) persons. In 7.6% of the films, cloning serves for resurrection of the dead. Human clones are also produced for companionship or help (5.6%) and organ donation (3.1%). 5.1% of the movies cover the cloning of extinct species.

24.8% of the movies present hybrids, including human-animal (8.6%) and animal hybrids (7.6%). 6.6% address the integration of human and alien DNA, and 1% apiece plant-human or animal-alien hybrids. 18.8% present recombinant DNA and 15.8% focus on genetic engineering not otherwise specified. 3.6% of the movies cover genetically modified viruses, while 2.6% treat about gene therapy. Surprisingly, only 1.5% of the movies portray genetically modified food.

Table 3

Biotechnologies presented in movies*

	N	%
Genetic engineering (not specified)	31	15.7
Genetically modified food	3	1.5
Gene therapy	5	2.6
Recombinant DNA	37	18.8
Hybrids		
animal hybrids	15	7.6
human-animal	17	8.6
human-plant	2	1.0
human-alien DNA	13	6.6
animal/alien DNA	2	1.0
GM viruses	7	3.6
Mitochondria	1	0.5
Genetic diagnostics	1	0.5
Cloning		
resurrecting famous characters and deceased relatives	16	7.6
resurrecting extinct species	10	5.1
cloning for organs	6	3.0
creation or replication of (ideal) individuals	21	10.7
cloning for companionship or help	11	5.6
Total	198	100

* Some movies covered more than one biotechnology.

Biotechnology as a New Source of Social Anxiety

Science and the cinema have been intertwined from the beginning of the 20th century when filmmakers were inspired by many scientific discoveries and inventions ranging from biology, physics and chemistry to medicine. Nonetheless, although popular culture covers many social fears generated by science, they are no longer triggered by vivisection, vascular surgery, transplantology, X-rays, atomic fusion or nuclear energy, but by biotechnologies. And although genetics was occasionally discussed in the movies from the 1950s and 1960s, it has become its main trope in the 1990s and 2000s (Turney 1998; Kirby 2000, 2002, 2003, 2007; Wood 2002; Jörg 2003; Dinello 2005; Glassy 2006; Haran et al. 2008). Thus, while in the fifties and the sixties mutations resulted mainly from radiation (*Godzilla*, *One!*, *Tarantula*) or toxic waste (*The Ape Man*, *Frogs*), from the early seventies they are caused by genetic engineering (*The Mutations*, *Piranha*, *Humanoids from the Deep*, *Forbidden World*). Moreover, in many adaptations of classic works original technologies are being

replaced by biotechnologies. For example, vivisection pictured in the first screen adaptation of Wells' novel—*The Island of Lost Souls* (1932), in 1996 gave way to genetic engineering. Similarly, the electricity used in the original story about dr. Frankenstein and its monster in 2004 was replaced by genetic engineering (*Frankenstein*). Similarly, in contrast to the original *Planet of the Apes* (1963), in its adaptation from 2011 apes acquire intelligence as a result of experimental genetic therapy for Alzheimer's disease. While in the original movie *The Fly* (1958) the scientist Andre Delambre transformed into a fly when his atoms mix with those of the insect, in a 1986 remake, the fusion of Seth Brundle and a fly occurs on a "molecular-genetic" level. Similarly, in the original comic story and its first adaptations: *The Incredible Hulk* (1978–1982) and *The Incredible Hulk Returns* (1988) Bruce Banner transforms into a giant green creature called the Hulk after being exposed to heavy doses of gamma radiation, in the movie from 2003 he is no longer a physicist but a geneticist and he inherits mutation from his father David who experimented on himself with the modified DNA of various animals. Also Peter Parker—a comic *Spider-Man*—gains his superpowers after being bitten by a radioactive spider, while in the movies from 2002 and 2012 it is a genetically-altered spider. Finally, the original *Teenage Mutant Ninja Turtles* (1987–1996) mutated after being exposed to radioactive waste, and in the 2014 cinema version it a mutagen created to cure diseases. Thus, while the cinema traces the developments of molecular biology and creates exaggerated expectations towards science (Brown and Michael 2003; Borup et al. 2006) it also reflects and fuels social anxieties related biotechnology. Interestingly, the old fears over science does not disappear but take a new form which is now epitomized by genetics (Turney 1998).

Simultaneously, over the years the cinema has not restricted itself to fearmongering, as many modern movies present stories of possible miracle healings and frame biotechnologies as future cures (*I Am Legend*, *Rise of the Planet of the Apes*, *Deadpool*). Nevertheless, still the image of genetics has no less dangerous connotations. This should not surprise, as every scientific revolution generates new fears and it is modern biotechnologies that embody our ambivalent attitudes towards science, which are stretched between wonder and horror, promise and fear. Consequently, many movies focus on the possible abuses or the failures of genetic research and follow the same premise: they demonize genetic research as the prediction of the apocalypse. Thus, although potential biofears are often juxtaposed with biohopes, in the context of genetics negative connotations with "bad" or "mad" science still predominate (Haynes 2006)—especially that while genetics was previously often pictured as a threat that could demolish only a few people (*Sssssss*, *The Mutations*, *The Island of Dr. Moreau*, *The Fly*), with the advent of the biotechnological revolution in the nineties it is framed as a threat that could annihilate whole societies or even the entire life on the planet (*Resident Evil*, *I Am Legend*, *I'm Not Jesus Mommy*).

Thus, while there has been a trend toward a more positive image of science and scientists (Haynes 2016) and the public is much more eager to accept taboo-breaking discoveries, including those related to reproduction and the creation of life, biotechnologies are still associated with horror, mystery or evil. Consequently, they are often framed as having a morally dark side. Nevertheless, biothreats are now blamed more on private biocorporations, which are pictured as operating in their own interests and outside of the ethical and legal regulations (*Jurassic World*, *Resident Evil*, *Okja*) (Dinello 2005; Meyer,

Cserer and Schmidt 2013). And while the typical pattern of "the mad scientist" seems to be disappearing from the cinema, geneticists are often portrayed as scientists who violate most of the cultural norms and taboos on natural laws and the sanctity of (human) life. At the same time, while earlier movies pictured geneticists as inherently evil or mad (*Sssssss*, *The Mutations*, *Island of the Fishmen*, *The Island of Dr. Moreau*), they are now often presented as those who warn against misconduct, the misuse of biotechnologies, and try to find a remedy. Moreover, many cinematic geneticists have noble goals, i.e. they intend to develop new medical therapies (*Regenerated Man*, *The Amazing Spider-Man*, *Rise of the Planet of the Apes*), fight some type of plague or hunger (*Night of the Lepus*, *Forbidden World*, *Mimic*, *Mega Piranha*) or try to help parents who want to have a baby (*No Ordinary Baby*, *Womb*, *Perfect 46*). However, apart from these good intentions they often fail through human weakness: they are overly ambitious and ready to use any methods, no matter how unethical, to achieve their goals (*Jurassic Park*, *Godsend*, *Sharktopus vs. Whalewolf*, *Replicas*). Thus, it is rather genetic knowledge that is framed as morally ambivalent, and no matter whether genetic research itself is pictured "mad," "bad" or "well-intentioned," it always has disastrous consequences: it is unpredictable, dangerous or wicked. The reason for this being so is that genetics reflects both our desire and fear to know. Thus, although the cinema proffers social enthusiasm about the benefits that biotechnologies may bring to society, filmmakers often underscore its unknown or unintended side effects. Consequently, the cinema often presents stories of how genetics unleashes a power that is beyond our control. All in all, as biotechnologies became a symbol of an increasing power of scientists, the image of dangerous science re-emerges. Simultaneously, the old motive of the irresponsible pursuit of knowledge for its own sake has been replaced by the one that is driven by profit (*Jurassic Park*, *Splice*, *Jurassic World*, *Consumed*, *Okja*). However, while in the sixties and the seventies movies focused on experiments with recombinant DNA (Kirby 2000, 2002, 2003), in the eighties and the nineties they clustered more around the manipulation of human genetic material and human cloning (Haran et al. 2008; O'Riordan 2008; Eberl 2010). Further progress in synthetic biology triggered an interest of the moviemakers in the possibility of creating artificial life (Franklin 2000; Meyer Cserer and Schmidt 2013).

This negative image of genetic science is best exemplified by the fact that most of cinematic genetic research is kept secret, is dangerous and runs out of control. Interestingly, accidents are often framed not as the failures of scientists but of science itself. This should come as no surprise as many biotechnologies are still perceived as socially and ethically problematic. In order to emphasize the dangerous and unethical dimension of genetic research scientific laboratories are often located in secret places, outside official institutions. Most frequently, it is an isolated and remote island (*She Demons*, *The Killer Shrews*, *The Island of Dr. Moreau*, *Island of the Fishmen*, *Attack of the Sabretooth*, *Jurassic Park*, *The Nest*, *The Curse of the Komodo*). And although in the popular imagination an island often represents a place of shelter, peace, beauty and happiness, in the cinema it symbolizes isolation, mystery, oddity, fear of the unknown and lack of social acceptance for genetic research (Kirby 2003: 255–256). Thus, the promise of an island is replaced by an inescapable structure of regulation and a dystopian, unnatural world created by geneticists excluded from society.

The lack of social acceptance of genetic experiments is also symbolized by the desert (*Resurrection of Zachary Wheeler*, *Parts: The Clonus Horror*, *The Island*, *Hulk*), the jungle

(*DNA*), swamps (*Swamp Thing*), an abandoned oil rig (*Proteus*), a remote submarine fuel base (*Deep Blue Sea*), an isolated, old rural farm (*Never Let Me Go*, *Morgan*) or another planet (*Forbidden World*, *Doom*). All these examples reflect social concerns that apart from the existing ethical and legal regulations, morally doubtful research can be conducted in research facilities that are hidden from the critical observation of the scientific community and society. Moreover, in some movies (*The Killer Shrews*, *She Demons*, *Jurassic Park*, *Deep Blue Sea*) the upcoming catastrophe is symbolized by a storm.

Such an image is reinforced by the presentation of biotechnologies as a form of science fiction (Hamilton 2003). Consequently, they arouse admiration, amazement, disbelief, but also fear and anxiety. Simultaneously, many possible future developments of biotechnologies are framed as already existing and real. Moreover, in order to create an impression that the future is now, the majority of the movies take place in the present while very few are set in the (distant) future. In this way, the cinematic coverage of biotechnology is characterized by two trends: while being framed as a futuristic project, science fiction itself is presented as a bad science. At the same time, cinema criticizes modern science by framing biotechnologies via opposed categories: good-evil, the known-the unknown, natural-artificial/technological, relativistic-deterministic, optimistic-pessimistic, the human-the inhuman, public-private. Such binary oppositions reflect and construct the relations between the social imagination on nature and cultural concepts of social order. They also help to establish and sustain the meanings of genetics and make moral judgements on biotechnologies. This is exemplified by the introduction of genetic "monstrous" threats into a stable situation (Stern 2004; Cruz 2012).

It Is so Simple: Picturing Biotechnologies

Because the aim of popular culture is to entertain rather than educate, the majority of movies rest on simplifications and reduce the information about the biological aspects of genetic phenomena to a minimum in favour of making the picture more attractive and dramatic. Very few movies explain genetic terms and processes, and the vast majority do not contain any information on the functioning of biotechnologies, which are often presented inaccurately and incorrectly. Neither do they show or explain the methods used by geneticists. For example, in most of the movies on human cloning clones are either formed as already adult persons or undergo accelerated growth, and rarely they are born as babies through their mothers. The procedure of cloning itself is also very unrealistic. Already in the first movie on human cloning: *Resurrection of Zachary Wheeler* a patient's DNA is sent to the laboratory by phone, and after being injected into the body, it provides a clone with the characteristics of the original within twelve hours. *The Clones of Bruce Lee* reduces cloning to blood sampling from the deceased Jeet Kune Do master. While in earlier productions such simplifications are understandable, they are also present in current movies (*Multiplicity*, *The 6th*, *The Other Me*, *Replicas*). In films where clones are born as babies through their mothers the simplicity of cloning is illustrated by the fact that it always occurs after the first attempt (*No Ordinary Baby*, *Blueprint*, *Godsend*, *Womb*). Thus, although the cinema focuses on cloning an individual from an adult cell, it seems to ignore the fact that it is much more difficult than cloning from an embryonic cell. Consequently, while the famous Dolly the sheep was born

only after 277 attempts, in most of the movies the procedure is almost always successful and flawless. Moreover, despite progress in genetic knowledge, still there can be observed an "imagination deficit" (Van Dijck 1999) as not only are the clones produced directly as adults but the cloning itself is presented as a creation of original's exact copy (O'Riordan 2008). Movies also decontextualize the clone's identity and accept the possibility of inheriting all the original's characteristics, including those with an obvious environmental component: memories, intelligence, aggressiveness or kindness (Eberl 2010).

Equally unrealistic are suggestions that dinosaurs can be recreated from chicken DNA (*Carnosaur*) or that one can get infected with the mutagen after being bitten by a transgenic animal (*Errors of the Human Body*, *The Shaggy Dog*, *Spider-Man*); dinking a beverage (*The Relic*, *Regenerated Man*); contracting a substance containing recombinant DNA (*Swamp Thing*) or eating transgenic animals or corps (*Humanoids from the Deep*, *Consumed*). This is of special importance as the public is often concerned that the mutation can be easily transmitted from GM organisms to humans or animals.

All these examples are intriguing because, although genetic research is relatively easy to represent in visual stories, the moviemakers are more focused on the results of genetic experiments than on the procedures themselves. In fact, genetic methods are often discussed only if they are socially perceived as problematic, i.e. as unethical, dangerous or criminal (*The Clone Master*, *The Boys from Brazil*, *No Ordinary Baby*). Apart from entertainment reasons, this results from the fact that one of the key strategies of fearmongering is not only to imply that the currently fictional applications of biotechnologies are already real but also that they are relatively simple and can be done by anybody. Thus, omissions or simplifications of technical aspects of genetic research allow the cinema to focus on traditional ethical concerns generated by biotechnologies rather than explain how they work. Showing how easy it is to clone a human being, produce a synthetic organism or resurrect extinct species, enables filmmakers to reproduce the old fears related to scientific progress: the alleged simplicity of genetic biotechnologies suggests that new Frankenstein monsters are just around the corner or are already here. Consequently, it reinforces the stereotypes about the esoteric and potentially dangerous character of biotechnologies.

Nevertheless, although the explanation of biotechnologies presented in the movies is usually reduced to a couple of sentences expressed in pseudoscientific jargon, some pictures contain the "kernels of scientific truth" (Rose 2007). In particular, this refers to *The Boys from Brazil* and *Jurassic Park*. The former contains a five-minute sequence explaining in detail the procedure of "mononuclear reproduction" and how genetic material is transferred via IVF. The latter presents a short animated tutorial how to clone dinosaurs from DNA preserved in their fossils. It is not surprising since many moviemakers employ science consultants whose job is to make the movie science seem plausible (Kirby 2011). It also helps to convince the audience that the movie scenarios are possible and reflect the real processes occurring in nature.

Interestingly, simplistic images of molecular processes and procedures are often contrasted with persuasive visualizations of DNA structure and mutations. Many movies present images of double helixes as central objects of cinematic laboratories where they are placed on computer screens and holographic displays of scientific plans (*Spider-Man*, *Teknolust*, *Carnosaur*). In all instances, DNA is pictured as a reified being, independent from the body. Consequently, as it is framed as the quintessence of life and ascribed

quasimystical power, it fills the audience with both admiration and fright (Nelkin and Lindee 1999). Nevertheless, such images contain an intrinsic contradiction: while they imply that molecular processes can be easily manipulated, altered or changed, they also amplify the belief that DNA is an autonomous being and suggest its omnipotent and uncontrollable character. They also enhance the belief that genetic research is very simple as it only takes DNA to create new life forms. Another contradiction behind these images is that although movies repeatedly emphasize that individuals are not determined solely by their genes and often include explicit statements against genetic essentialism, they reproduce a common belief that it is DNA that is the core of human identity. Simultaneously, while looking at the visual representation of genetic mutations one can observe that the cinema focuses on their darker side: most commonly the results of genetic experiments are presented as strange, odious or abnormal monsters (*Swamp Thing*, *Forbidden World*, *The Fly*, *Watchers*, *Doom*). Nevertheless, it seems that images of horrific mutated creatures bring our attention more to their creators, who are either mad or unable to control the genetic processes, rather than genetic monsters themselves. Thus, the images of the double helix and mutations represent ambivalent attitudes towards genetic experimentation: while the former stands for our hopes and optimism, the latter represents social anxieties and fears.

Genetics Is a Risky Enterprise

Although biotechnologies in movies are presented as relatively simple, they are also framed as risky and dangerous. Simultaneously, the cinema stresses two types of genetic risks: biotechnological and moral. The former relates to the risks new genetic technologies pose to living organisms. For example, movies often stress the fact that for every beneficial genetic modification there are hundreds of others which result in defects, malformations and deaths (*She Demons*, *Sssssss*, *The Mutations*). In other films clones suffer from RNA degradation (*Star Trek: Nemesis*), personality disorders (*Æon Flux*), develop brain tumours, internal organs outside the body or become extremely violent (*The Reconstruction of William Zero*, *Morgan*). Movies also present laboratories full of deformed, impaired clones (*Alien: Resurrection*, *The 6th Day*, *Shadow Fury*, *The Shaggy Dog*). It also highlights the risk that biotechnologies pose to the entire society when the premature implementation of gene therapy with the use of bioengineered viruses leads to a global outbreak and the extinction of humankind (*Resident Evil*, *I Am Legend*, *Rise of the Planet of the Apes*). On the other hand, moral risks highlighted by the movies refer to filmmakers concerns that technoscientific progress is constantly moving the ethical boundaries in the direction of what is technically possible. Such anxieties are epitomized by dr. Wells who says in *Godsend*: "If I'm not supposed to do this, Paul, then how is it that I can?". Similarly, dr. Malcom warns the owner of *Jurassic Park*: "Your scientists were so preoccupied with whether or not they could that they didn't stop to think if they should."

Interestingly, although the biological and moral risks are often intertwined, the cinema focusses mainly on its ethical dimension. Again, it is best exemplified by the way movies picture human cloning. While one of the main concerns generated by reproductive cloning relates to the medical risks, most of the analyzed movies concentrate on the ethical dilemmas generated by the procedure. Consequently, cinematic discussion on cloning

focuses around three main topics: 1) the unethical motivations of cloners: resurrecting deceased individuals, including dictators (*Boys from Brasil*, *Godsend*, *I'm Not Jesus Mommy*), cloning for organs (*The Third Twin*, *The Island*, *Never Let Me Go*) or using human clones as a means to an end (*Multiplicity*, *Xchange*, *Moon*); 2) dangers it poses to human individuality and uniqueness (*Brave New World*, *The 6th Day*, *Blueprint*); and 3) the inability of society to control scientists (*Godsend*, *No Ordinary Baby*, *Replicas*). Additionally, many movies raise questions about who should decide about who is to be cloned, how would a clone relate to its original, how would they fit into society and, most importantly, whether or not clones are real human beings (*The Island*, *Teknolust*, *Blade Runner 2049*). Thus, as the cinema focuses on the (un)ethical dimension of genetic research, it is usually pictured as unnatural and an blasphemy.

Simultaneously, the most common arguments against genetic research: objection to 'playing God', 'designer babies', or eugenics, are often used in the movies not because they are ethical arguments but because they are an integral part of popular culture, i.e. they refer to the established interpretations of the world deeply rooted in Western culture (Turney 1998). Thus, although both cinematic images of biotechnologies and laboratory creations change over time, they all have one thing in common: they represent the story of a power beyond our dreams and beyond our control. Consequently, the cinematic appeal to moral risks reflects two cultural myths and fears established in our culture: the one of too much knowledge, and that some things should remain unknown (Haynes 2006). Thus, although the biotechnological risks presented in the movies vary over time and genres, the common cinematic trope is that of the original Frankenstein story of science gone wrong or science gone right but with unforeseen and dangerous consequences. It suggests that genetic experiments will lead to a failure in the scientific and the human dimension (Franklin 2000). Furthermore, it refers to the unpredictability of science and to the ambitious and proud scientists. In both cases, the monster/doctor Frankenstein serves as a warning against scientists' tendency for "moral trespass" and going beyond "societal standards," which always comes with unpredictable challenges and unexpected consequences for the creator and society.

All in all, while the cinema is not questioning the usefulness of biotechnologies, it is concerned over the unpredictable consequences they may have for society and constantly warns against the absence of scientists' learning experience and feeling of responsibility. It also stresses that the emphasis on the intellectual gains stemming from biotechnologies results in a negligence of its moral dimension.

It's Only a Mutation

While changes in genetic material are the basic mechanism of evolution and the differentiation of species, popular culture associates terms like "mutation," "mutate" and "mutant" with "contamination," "pollution" and a "threat" (Condit et al. 2002). Thus, although mutations can be bad, good, both or neither, in movies seldom they are a good thing. On the contrary, they are pictured negatively as things that society should fear, i.e. they are harmful; not necessarily to the "mutants" themselves but to their creators or the society. Such an image is reinforced by the conflation of genetic alterations with phenotypic changes, as mutants are often differentiated physically. Consequently, most cinematic mutations are mon-

strous: they cause accelerated and radical change in the organism's appearance, physical abnormality and a loss of symmetry. Frequently, they destroy the organism's physique and transform its behaviour (*Sssssss*, *The Mutations*, *The Fly*, *Hulk*, *The Amazing Spider-Man*, *Deadpool*). Moreover, as Ronald Cruz (2012) observes, as changes caused by mutations are often nonadoptive, in movies they cause a loss of humanity. Finally, cinematic mutations usually do not depend on the environment but are caused by geneticists; and even if planned, they occur suddenly and run out of control.

Interestingly, while nature does not work intentionally, evolution lasts a long period of time and new mutations are extremely rare, the cinema suggests that each mutation causes a specific feature. However, as David Kirby (2003: 247) suggests, moviemakers choose rapid mutations over the slow process of mutation because they are much more exciting and frightening. Negative image of mutations is further strengthened by the erroneous idea about the inheritance of acquired features (*The Fly 2*, *Mimic*, *Jack Frost 2*, *Hulk*). Thus, the significance of "genetic mutation" as a movie concept rests on its symbolic meaning as randomness and unpredictability of mutations serve as a metaphor for the disaster caused by uncontrollable science. Although scientists try to convince the public that they are able to control nature, moviemakers use mutations to symbolize the most frightening thing about genetics: scientists' loss of power over the biotechnologies.

Simultaneously, although most cinematic mutations have negative consequences, it is adaptations of comic stories about superheroes that stress their importance and positive role in evolution. Moreover, mutants are imagined as special individuals with super powers (*Blade*, *Spider-Man*, the *X-men* saga). Nevertheless, because mutants are phenotypically different, they are also perceived as a social threat.

DNA: the Molecule of Life

Regardless of whether biotechnologies are presented as simple and safe or complicated and dangerous, DNA itself is framed as an omnipotent molecule, the essence of life and existence (Nelkin and Lindee 1999; Van Dijck 1999; Franklin 2000). As nature and life itself has been increasingly biologized and biology has been increasingly geneticized, the cinema supports the idea that genes and DNA are the only factors responsible for one's physique, personality and behaviours, and that they contain a complete instruction for the creation of life. Even in the earlier productions, where genetic material is defined as abstract, "Character X" (*She Demons*), "inherited factors" (*The Killer Shrews*) or "mysterious essence" (*The Mutations*) it is assumed that it codes all the features of the organisms. Nevertheless, also in *Blueprint* dr. Fischer explains to Iris that DNA is her "life's software" and contains "everything that makes you special." In other films DNA is framed as a mysterious, autonomous being, which undergoes spontaneous mutations (*Mimic*, *Jurassic Park*). It confirms Kirby's (2003, 2007) claim that "scientific materialism" is the dominant ideology pictured in the movies. Indeed, the image of the DNA molecule in the cinema is a quintessence of the idea that there is only one, natural reality and that it can be known and explained only by science. Thus, as movies support the belief that a single molecule can explain the nature of life, DNA and the genome become metaphors for stability, determinism and resistance to change. Consequently, as the "ultimate explanation"

and material marker of life itself, DNA is referred to as a reified being, independent from the body and the core of human identity. Such ideology is best pictured in *Gattaca* when Jerome reassures Vincent that his mystification will never come out as society no longer sees individuals as persons but is focused on their genetic profiles. Thus, while the message behind most of the movies is anti-deterministic, the popularity of genetic essentialism results from the fact that it embodies a Premodern search for a naturalistic explanation of identity and typical of Modernity belief in science.

Significantly, the belief that DNA constitutes a relatively simple "recipe" for building any living organism is symbolically represented in the opening credits of many movies which utilize the images of the letters of the "genetic alphabet": A, C, G and T, representing the four DNA bases (*Gattaca*), the double helix (*Teknolust*, *X-Men: Days of Future Past*), nucleic acids (*Carnosaur*), genes and cells (*The Island of Dr. Moreau*) presented as autonomous beings, abstracted from the rest of the organism. Such images support the idea that life is just a molecular process regulated by genetic information transcribed in the cell. Consequently, a detective in *Jack Frost* argues that the human soul is a chemical, and dr. Ferrami in *The Third Twin* believes that: "everything comes to chemistry." Such genetic thinking is strengthened by the conviction that aliens also have DNA, although usually it is framed as more perfect and powerful than ours, and that it may take over the human body (*Evolution*, *Species*, *Alien: Resurrection*).

Nature vs Nurture

By stressing that DNA constitutes the ontological foundation of existence, some movies frame DNA as "the genetic blueprint for the soul" which determines whether a person is inherently "good" or "evil" (*Doom*). Others, reproduce the idea that one's personality and identity are written down in the genes (*Godsend*, *I'm Not Jesus Mommy*). Nevertheless, most films reject such a deterministic view on nature and stress the significance of the environmental factors and socialization (*The Clone Master*, *No Ordinary Baby*, *The Third Twin*, *Blueprint*). Moreover, the cinema emphasizes that even socialization and a similar environment do not suffice to create a perfect copy, as one's identity results from the interaction of biological factors, the social environment and the historical context (*The Boys from Brazil*, *Anna to the Infinite Power*, *Gattaca*).

Thus, while none of the movies question the importance of genes for our identity nor the usefulness of biotechnologies, they warn against the promulgation of the belief that an individual is just the sum of their genes. And the point behind this anti-essentialist and anti-deterministic message is that we are not prisoners of our genes and that being human means to transcend our genetic fate. Ultimately, even the perfect vampire hunter Blade, Peter Parker or the mutants from the *X-men* saga, who owe their super powers to genetic mutations, are not determined by their genetic make-up. They do not have to use their powers; instead they choose to do so and to use them for a good cause. Thus, it is personal choice not genetics itself that determines their identity. Nevertheless, as David Kirby and Laura Gaither (2005: 281; Gavaghan 2009: 77–78) observe, the problems with their identity results not from being mutants as from the fact that a genetic transformation has been imposed on them and they had no choice.

Cinematic Bioanxieties

Life Finds a Way

Although the cinema rejects the essentialist and deterministic vision of genetics, it is infiltrated by the idea that biology can be reduced to genetics and that life itself is a reprogrammable in-*form*-ation inscribed in the genes. It also perpetuates the belief that genetics, as a science of information, can help to trans-*form* life itself. Consequently, as biology becomes increasingly geneticized, technologized and informatic, and life is no longer conceived, born and bred but engineered, the cinema does not relate creation with the biblical or Darwinian tree of life but with the sterile laboratory where scientists combine and mix different components and imitate life (Franklin 2000). Simultaneously, by picturing how genetics manufactures and mimics life, the cinema reminds us about the borders of real life, i.e. that it can be both created and destroyed. For that reason it is not surprising that from the very beginning, when the cinema focused on genetics it has been spinning visions in which geneticists try to control evolution and enhance (human) nature. Nevertheless, although movies present biotechnologies as a technoscientific means for (re)creating life, genes and DNA are pictured as autonomous and potentially dangerous entities which may take control over their own development and become a deadly threat to society. As genetic experimentations with life become a form of authorship they always come with unpredictable and unexpected consequences either for the creator or society (Stern 2004), and result in the creation of a new demons—monsters of science: dangerous mutants (*Night of the Lepus*, *Frankenfish*) and hybrids, including: interspecific (*Mimic*, *Jurassic World*, *DNA*), human-animal (*Island of the Fishmen*, *Splice*, *Proteus*), human-plant (*Konga*, *The Mutations*, *Swamp Thing*) and human-alien (*Forbidden World*, *Species*, *Alien: Resurrection*, *Doom*).

Thus, the movies warn that in contrast to geneticists' pride and arrogance, full control over nature is impossible as nature always finds new ways for adaptation. Consequently, cinematic genetic experiments usually get out of control, ending in a disaster either for the researchers or the entire society (*The Killer Shrews*, *Mimic*, *Sabretooth*, *Resident Evil, Godsend*, *Black Sheep, I Am Legend*, *I'm Not Jesus Mommy*). So, the cinema constantly alerts us against the short-sightedness of geneticists who believe that they are able to fully understand and control biological processes and do not know when to stop their experiments. As dr. Malcolm warns the owner of the *Jurassic Park*: "Life breaks free, it expands to new territories and crashes through barriers … life … finds a way." Thus, the cinema constantly stresses the fact that biotechnologies exceed both our ideas about the potential of science and our capability to control the forces liberated in the laboratory. And while films try to convince the public that new genetic technologies can mimic the creation of life, they also remind us that there was only one true Genesis, that life is uncontainable and uncontrollable, and genetic experiments will always result in failure, destruction or carnage.

The Militarization of Biotechnology

Despite the anxieties related to the inability to control molecular processes, the cinema suggests that it is not the biotechnologies *per se* nor the scientist who pose a real threat, but rather the biomedical military-industrial complex, i.e. the politicization and militarization of genetic technologies (Wasson and Grieveson 2018; Dinello 2005: 202–

203). By pointing to the dangers related to using genetic engineering for military purposes, movies present visions where social catastrophe results from the alliance between the unholy trinity: (bad) science, the government and military agencies. Most of these movies focus on using bioengineering for the creation of genetically modified viruses (*Resident Evil*) and animals which serve as biological weapons (*Piranha*, *Bats*, *Venomous*, *Black Swarm*, *Watchers*, *Leviathan*, *Mutant Species*). In the other cases, scientists working for military agencies are using recombinant DNA and cloning to produce genetically enhanced "killer supersoldiers," who are extremely strong, fit and tough, have the ability to regenerate wounds and an increased level of aggressiveness, lack empathy and manifest blind obedience (*The Clones of Bruce Lee*, *Universal Soldier*, *Shadow Fury*, *Natural City*, *Morgan*). Thus, by showing how government agencies ignore scientists' ethical concerns the cinema suggests that it is not genetics that should be mistrusted but rather those in power, who use biotechnologies as a tool for ideological, political and financial purposes.

The Commercialization of Biotechnology

While concerns regarding the militarization of biotechnology were a common trope, especially in the seventies and the eighties, which echoed the discussion on the recombinant DNA, as the biotechnological industry flourished rapidly in the nineties, many movies stress the commercial value of biotechnologies and picture them as a leading branch of the economy. Simultaneously, the cinema emphasizes fears related to the commercialization of biotechnologies (Dinello 2005; Meyer, Cserer and Schmidt 2013). In particular, popular culture criticizes the role international biocorporations play in the process and suggest that they corrupt scientists and control their research to maximize profits. At the same time, the cinema often suggests that working for a large corporation is not a matter of one's selling up, but the only alternative. Thus, in *Jurassic Park* dr. Hammond convinces a leading geneticist of the InGen Corporation, Henry Wu that: "If you want to do something important in computers or genetics, you don't go to a University." Nevertheless, the cinema constantly warns that the subordination of science to the capitalist market and the constant pursuit of fame and fortune inevitably lead to the betrayal of the scientific ethos, as geneticists have to adapt to the corporation's expectations, even if it means the omitting or falsification of undesired research results (*Consumed*, *Okja*).

While criticizing the dependence of science on private business, the cinema also stresses the pressure it puts on researchers, which results in the negligence of possible risks and the premature implementation of biotechnologies. This in turn may lead to a catastrophe (*Deep Blue Sea*, *The Amazing Spider-Man*, *Rise of the Planet of the Apes*). Other movies picture the specificity of the scientific culture, which puts the scientist under constant pressure to get a financial grant from rich sponsors and where rivalry and the "publish or perish" pressure dominate (*Nutty Professor*, *Blueprint*, *Errors of the Human Body*).

Thus, although the cinema is fascinated with geneticists' ability to create life, it criticizes technoscience's dehumanizing power to commodify different life forms. Geneticists' trivial motives of entertainment and profit do not justify the risk associated with producing new life forms (Franklin 2000; Wood 2002; Stern 2004). Cultural hopes and fears of bioengineered organisms as commodities are best depicted in movies on reproductive cloning which exemplify Schmeink's (2015: 133) argument that human procreation has become

a specific market and that human life itself is a commodity to be traded. Although sometimes human cloning is pictured as a health care option (O'Riordan 2008), movies usually suggest that it will be accessible only to the rich (*Resurrection of Zachary Wheeler*, *Parts: The Clonus Horror*, *Cloned*, *The Island*, *Never Let Me Go*). Movies also show how bioengineered life of the clones may be used and abused and how its commodification leads to the dehumanization of living beings who deserve moral recognition. Moreover, as Western culture is driven by competition and consumption typical of the capitalist market, the cinema warns that the progress of biotechnologies will lead to the emergence of a unique "genetic supermarket" in which prospective parents can select the traits of their future children (*Gattaca*, *The Perfect 46*).

More Human Than Humans

Finally, the cinema expresses the social anxieties related to the possibility of using biotechnologies for political purposes and the building of an "ideal" society. By showing the increasing role of biotechnologies, such movies as *Brave New World*, *Gattaca*, *Code 46* or *Natural City* present dystopic visions of societies based on biology, where the propaganda of perfection and biotechnologies legitimizes social control and political dominance. Moreover, as geneticists often use biotechnologies to create new race of superhumans (*The Unborn*, *Frankenstein*, *Blade Runner*, *Twins*, *Blade Runner 2049*), such scenarios nearly always refer to eugenics (Kirby 2000, 2002, 2007; Gavaghan 2009). Nevertheless, while the cinema accepts the possibility of perfecting humankind, it rejects the idea that it can be achieved via biotechnologies. Moreover, "perfection" is often pictured as undesirable as it is stressed that scientists' attempts to make us "More human than human" (*Blade Runner*) will actually destroy our humanity. Indeed, while the genetically engineered individuals in *Brave New World* or *Code 46* are healthier, more intelligent, beautiful and athletic, they do not have any aspirations, desires or dreams, and neither do they fight nor love. Their "superhumanity" makes them soulless, dispassionate, emotionless and devoid of spontaneity. They also experience existential emptiness (*Gattaca*, *Frankenstein*, *Blade Runner 2049*). Thus, the cinema constantly asks what "genetic perfection" means and what price, in human dimensions, we have to pay for our quest for perfection.

Simultaneously, the cinema warns against the political dimension of biotechnologies and shows how the principles of mass production may be applied to biology and enable the government "breeding" of standardized individuals (*Brave New World*, *Code 46*, *The Island*). Thus, although biotechnological utopias presented in movies are free from diseases, depression, madness, social conflicts and violence they are always characterized by omnipresent repressive social engineering. Moreover, politicization of biotechnologies leads to a radical polarization of society which becomes divided into a genetically enhanced superior class and naturally born pariahs (*Gattaca*, *Code 46*). And while the cinema stresses the fact that biotechnologies may become a foundation for genetic discrimination woven into the society and the State, it also expresses concerns related to liberalization of eugenics, when it becomes regulated not by the government but by the free decisions of prospective parents. Thus, both *Gattaca* and *Perfect 46* suggest that a new, liberal eugenics will not be the domain of scientists and politicians, but it will be regulated by individual preferences typical of the market economy. Consequently, movies argue that constant pressure to

succeed may encourage individuals to choose biotechnologies, which may lead to the emergence of a uniformed society in which "there is no place for uniqueness" (Stacey 2005; Kirby and Gaither 2005; Gavaghan 2009). And although movies frequently distinguish "procreative beneficence" from eugenics, they accuse geneticists for promoting "designer babies" and "backdoor eugenics."

Interestingly, while it is widely assumed that biotechnologies will liberate our human potential, many movies present them as a tool for enslavement. Both human clones, in *Resurrection of Zachary Wheeler*, *The Clones* or *The Island*, dr. Moreau's beast-people, and genetically engineered supersoldiers, are creatures totally subordinated to and dependent on their creators. Moreover, with the exception of *Gattaca*, in which genetically enhanced individuals occupy socially exposed positions, in *Blade Runner*, *Natural City*, *Moon* or *Blade Runner 2049* biogenetic cyborgs and replicants are modern slaves used for dangerous, degrading or boring work in off-world colonies, which they are prohibited to leave. "Perfect" as they may seem to be, they are second class citizens and are deprived of all rights. Paradoxically, although most films support the idea that humanity may be improved by technological means, they show how in dystopian societies of the future bioengineering helps to reproduce the practices from the past: with the creating and legitimization of a totalitarian regime and the production of perfect slaves. Thus, movies share the message that society should not be focused on altered genes but an equal chances.

Conclusion

Although genetics has become one of the most important scientific revolutions of the last few decades due to rapid advances in modern biotechnology, the public find it difficult to keep up with the most recent findings of genetic sciences. Consequently, there is a huge gap between what the public (think they) know about genetics and what genetics really is (Van Riper 2003; Chapman et. al. 2019). For that reason, there is an urgent need to increase the public's biotechnological literacy (González et al. 2013; Stern and Kampourakis 2017), especially that it is often popular culture not formal education that shapes people's understanding of genetics (Handlin 1965; Turney 1998; van Dijck 1998; Nelkin and Lindee 1999; Van Riper 2003; Bates 2005; Feinstein, Allen and Jenkins 2013; Roberts et al. 2019). However, it should not be surprising as the images of biotechnologies depicted in movies are more eye-catching, persuasive, memorable and easy to understand. Simultaneously, while popular culture provides a rich source of means which aids the moviemakers to frame genetics, and many movies contain elements that may facilitate education on genetic issues, their main objective is to authenticate the artistic visions, as the references to biotechnologies make cinematic stories seem more than just a fantasy (Kirby 2011). Moreover, because the rules of moviemaking emphasize rather commercial issues, the attractiveness of the story is more important than a reliable scientific theory. Consequently, cinematic images of biotechnologies are overly simplified and often lead to erroneous or outdated ideas related to genetics. Thus, movies may (re)create cognitive barriers and preserve the existing stereotypes about science (Eberl 2010; Muela and Abril 2014). This is important because research shows that persons whose image of science is

based on television programs are less positively oriented towards science and believe that it is dangerous, and that scientists are weird (Gerbner 1987; Eurobarometer 2010).

At the same time, although misrepresentations and misconceptions of genetics and biotechnologies represented in the movies may negatively influence public understanding of genetics, the cinema offers some opportunities for education on the functioning of genes, their influence on the development of living organisms, whether DNA is sufficient for creating life and how biotechnologies work (Rose 2007; Muela and Abril 2014). Moreover, because genetics is, without a doubt, one of the most essential narrative tools that helps the moviemakers to organize the plot, attract the audience and focus their identification, cinematic depictions of biotechnologies enable to express social hopes and anxieties related to the scientific revolution (Dinello 2005; Merzagora 2010). Consequently, movies play an important role in education on the ethical, social, economic and legal consequences of the genetic revolution, which influence social acceptance of biotechnologies (Schibeci 1986). Indeed, popular culture is a symbolic resource and a unique "guide" which helps individuals to understand and evaluate the social implications of scientific progress (van Dijck 1998; Turney 1998; Hamilton 2003; Bates 2005). Of course, the impact of popular culture is not decisive. Nevertheless, because it provides individuals with pictures, arguments and examples for discussion on the extragenetic implications of biotechnologies, it is hard to overestimate its influence on public understanding of biotechnologies.

Thus, while biotechnological tropes appearing in movies vary over time and genres, they have cultural resonance: they enable the public to recognize the character of biotechnology more easily and influence public perception of science. However, cinematic understanding of biotechnologies is not only about knowing biotechnologies as technical phenomena (what they are, where they came from and how they work), but it also involves seeing how they influence society. It is of special importance because there is a sort of hype associated with genetic science which is often framed as the technology of the future (Brown 2003; Caulfield 2004). Although genetic imaginaries depicted in movies often foreshadow the biotech developments of the future and may stimulate the direction of scientists' own work, they influence how the public understands genetics: what it expects, what it desires and what it fears. Thus, while the genohype often makes everything seem novel movies are cultural communicators that have the power and ability to distort scientific values and create exaggerated expectations or fears (Brown and Michael 2003; Borup et al. 2006). Indeed, such cinematic pictures as *Jurassic Park*, *Gattaca*, *The Island*, *I am Legend*, the *X-Men* saga, *Womb*, *The Perfect 46*, *Consumed* or *The Replicas* both reflect and shape social ideas on how genetic science is done, how various biotechnologies operate and what ethical, legal and social consequences emerge from the biotechnological revolution. This is especially the case for biotechnologies that while being in progress, they have still not fully demonstrated their practical utility or safety (i.e. cloning, gene therapy, synthetic biology). Thus, cinematic depictions of biotechnology always focus our attention on the genohype, biopromises and biofears and remind us that biotechnologies require weighing the value of present expectations, hopes and "knowns" against the potential risks.

Thus, it is not surprising that while documenting scientific progress popular culture focusses on social anxieties related to biotechnologies. And although it is difficult to generalize, since the landscape for genetics and cinema has changed significantly since the

1950s, this analysis confirms that through its history the cinema reflects and (re)constructs deep-rooted cultural attitudes of suspicion, mistrust, anxieties and ambivalence toward science, which are nowadays expressed by biotechnologies (Turney 1998; van Dijck 1998; Wood 2002; Dinello 2005; Glassy 2006; Roberts et al. 2019). It also shows that while popular culture promotes the popularization of biotechnologies, it also creates and sustains the popular image of genetics as unpredictable, potentially dangerous or unethical science. Moreover, many movies reproduce the scheme known from the stories about Frankenstein, Faust or Golem: far from human settlements a genius or a mad scientist brings to life a new monster, which gets out of control, threatening the whole of humanity (Haynes 1994; Jörg 2003). At the same time, the popularity of stories and cinematic images of biotechnologies stems from that they are stories about life itself and its creation. Consequently, as Franklin (2000: 197–198) observes they refer to a universal essence of humanity, a shared, primordial ontology.

However, while in the sixties and the seventies movies focused on experiments with recombinant DNA (Kirby 2000, 2002, 2003), in the eighties and the nineties they clustered more around the manipulation of human genetic material and human cloning (Haran et al. 2008; O'Riordan 2008; Eberl 2010). Further progress in synthetic biology triggered an interest of the moviemakers in the possibility of creating artificial life (Franklin 2000; Meyer Cserer and Schmidt 2013). Moreover, while earlier movies framed human clones as nonhuman, soulless bad copies (*Resurrection of Zachary Wheeler*, *The Clones*, *Parts: The Clonus Horror*), passive individuals controlled by their evil creators (*Clones of Bruce Lee*, *American Ninja 2: The Confrontation*, *Universal Soldier*) or freakish and odious beings (*Godsend*, *I'm Not Jesus Mommy*), nowadays human cloning articulates the posthuman discourse on the matter of identity and the human/nonhuman boundary. Human clones or genetically enhanced individuals are pictured as individuals who experience identity crises and struggle for answers as to what it means to be "fully human" (*Teknolust*, *Blueprint*, *The Island*, *Never Let Me Go*, *Reconstruction of William Zero*, *Blade Runner 2049*) (Kirby and Gaither 2005; Haran et al. 2008; Eberl 2010). Similarly, although reproductive cloning is usually pictured negatively, its image has also changed as it often includes a positive dimension such as a "human-saving technology" (*Aeron Flux*, *Replicas*) or "possible therapeutic technology" (*The Island*, *The 6th Day*) (O'Riordan 2008). Thus, while human cloning is still a paradigmatic example of genetics breaking a taboo, the cinematic image of clones as artificial, imperfect or inhuman beings has now changed and many modern movies picture clones in a more positive light: as innocent, good individuals (*Multiplicity*, *The 6th Day*, *Moon*, *Blueprint*, *Never Let Me Go*, *Oblivion*, *Replicas*). Consequently, as the cinema accustoms us to the idea of reproductive cloning, it also shapes our thinking about human clones as human beings. Apart from this, however, bioengineered creatures, whether hybrids (*Splice*, *Jurassic World*), clones (*Godsend*, *I'm Not Jesus Mommy*) or synthetic, human-like beings (*Blade Runner*, *Morgan*), often evoke the cultural myth about the Frankenstein monster (Turney 1998; Meyer, Cserer and Schmidt 2013; Schmeink 2015). Thus, although the prevalence of genetic tropes varies over time and across genres, the foregoing examples show how movies document the technoscientific progress, create (exaggerated) expectations towards science and (re)construct social anxieties related to the genetic revolution.

Simultaneously, the old fears of genetic mutants are being replaced by the threats bioengineering creates for the human identity (Kirby and Gaither 2005; Kirby 2007) and those resulting from the militarization and the commercialization of genetics (Wasson and Grieveson 2018; Dinello 2005; Meyer, Cserer and Schmidt 2013). In fact, modern cinema stresses the fact that nowadays the bigger threat to social order comes not from genetics itself but from the alliance between science and the military or private business. Thus, while the cinema has become a key vehicle of science communication, science fiction serves moviemakers as social criticism and popular philosophy. The cinema questions the "objectivity" of genetic science and critically evaluates the social consequences of scientific development and warns against the arrogance and short-sightedness of scientists. The persuasiveness of cinematic images results from the fact that many movies do not evoke fictitious biotechnologies or their unrealistic applications, but they show how the uncontrolled usage of biotechnologies already present can influence society. Moreover, frequently the only futuristic aspect of the movies is the dissemination of biotechnologies, but they lack such typical elements of science fiction as futuristic architecture, infrastructure or clothes, which makes these scenarios even more real and disturbing.

All in all, despite some limitations resulting from an underrepresentation of non-American films, it is possible to reach some interesting and sociologically important conclusions. Most importantly, this research highlights the fact that while the cinema documents developments in molecular biology and cultivates expectations about genetic science it also expresses the ambivalent attitudes towards biotechnology and scientific progress in general. Secondly, because cinematic representations of biotechnologies are often very simplistic and erroneous there movies may reinforce negative stereotypes about biotechnologies, and for that reason there is urgent need to increase the public's biotechnological literacy. Thirdly, even though movies revive, nurture and reinforce the old myths and anxieties related to biotechnologies they may play some role in education on the ethical, legal and social issues related to genetic sciences.

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Appendix 1
List of Selected and Analysed Movies

Movie tittle	Year of release	Country	Director	Box office US	Box office worldwide
She Demons	1958	USA	Richard E. Cunha	No data available	No data available
The Killer Shrews	1959	UK	Ray Kellog	$1,000,000	No data available
Konga	1961	USA/UK	John Lemont	No data available	No data available
Resurrection of Zachary Wheeler	1971	USA	Bob Wynn	No data available	No data available
Night of the Lepus	1972	USA	William F. Claxton	No data available	$3,711,923
Sssssss	1973	USA	Bernard L. Kowalski	$1,000,000	No data available
The Clones	1973	USA	Lamar Card, Paul Hunt	No data available	No data available
Sleeper	1973	USA	Woody Allen	$18,344,729	No data available
The Mutations	1974	USA/UK	Jack Cardiff	No data available	No data available
The Island of Dr. Moreau	1977	USA	Don Taylor	$8,000,000	$11,000,000
Clones of Bruce Lee	1977	Hong Kong/Philippines	Joseph Kong	No data available	No data available
Piranha	1978	USA/Japan	Joe Dante	No data available	No data available
The Clone Master (TV movie)	1978	USA	Don Medford	Not applicable	Not applicable
The Boys from Brazil	1978	USA/UK	Franklin J. Schaffner	$19,000,000	No data available
Prophecy	1979	USA	John Frankenheimer	$22,673,340	No data available
Island of the Fishmen	1979	Italy	Miller Drake, Sergio Martino	No data available	No data available
Parts: The Clonus Horror	1979	USA	Robert S. Fiveson	No data available	No data available
Brave New World (TV movie)	1980	USA	Burt Brinckerhoff	Not applicable	Not applicable
Humanoids from the Deep	1980	USA	Barbara Peeters, Jimmy T. Murakami	$2,500,000	No data available
Piranha 2: The Spawning	1981	USA	James Cameron, Ovidio Assonitis	No data available	$2,062,070
Star Trek 2: The Wrath of Khan	1982	USA	Nicholas Meyer	$78,912,963	$95,800,000
Swamp Thing	1982	USA	Wes Craven	$192,816	$274,928
Anna to the Infinite Power	1982	USA	Robert Wiemer	No data available	No data available
Forbidden World	1982	USA	Allan Holzman	No data available	No data available

Movie tittle	Year of release	Country	Director	Box office US	Box office worldwide
Blade Runner	1982	USA	Ridley Scott	$32,868,943	No data available
Creator	1985	USA	Ivan Passer	$5,349,607	No data available
The Fly	1986	USA/UK/Canada	David Cronenberg	$40,456,565	$60,629,159
American Ninja 2: The Confrontation	1987	USA/South Africa	Sam Firstenberg	$4,000,000	No data available
The Nest	1988	USA	Terence H. Winkless	No data available	$3,765,000
Twins	1988	USA	Ivan Reitman	$111,938,388	$216,614,388
Watchers	1988	Canada	Jon Hess	$940,173	No data available
The Fly 2	1989	USA/UK/France	Chris Walas	$20,021,322	$38,903,179
Leviathan	1989	USA/Italy	George Pan Cosmatos	$15,704,614	No data available
Godzilla vs Biollante	1989	Japan	Kazuki Ohmori	No data available	No data available
Watchers II	1990	USA	Thierry Notz	No data available	No data available
The Unborn	1991	USA	Rodman Flender	$1,159,578	No data available
Universal Soldier	1992	USA	Roland Emmerich	$36,299,898	$101,999,898
The Cloning of Joanna May (TV movie)	1992	UK	Philip Saville	Not applicable	Not applicable
Jurassic Park	1993	USA	Steven Spielberg	$402,453,882	$1,029,153,882
Carnosaur	1993	USA	Adam Simon	$1,753,979	No data available
Replikator: Cloned to Kill	1994	Canada	Philip Jackson	No data available	No data available
Watchers 3	1994	USA	Jeremy Stanford	No data available	No data available
The Unborn II	1994	USA	Rick Jacobson	No data available	No data available
Regenerated Man	1994	USA	Ted A. Bohus	No data available	No data available
Mutant Species	1994	USA	David A. Prior	No data available	No data available
Judge Dredd	1995	USA/UK	Danny Cannon	$34,693,481	$113,493,481
Carnosaur 2	1995	USA	Luis Morneau	No data available	No data available
The City of Lost Children	1995	France/Germany/Spain/Belgium/USA	Jean-Pierre Jeunet, Marc Caro	No data available	$1,738,611
Piranha	1995	USA/Japan	Scott P. Levy	No data available	No data available
Nemesis 2: Nebula	1995	USA	Albert Pyun	No data available	No data available
Species	1995	USA	Roger Donaldson	$60,074,103	$113,374,103
Proteus	1995	UK	Bob Keen	No data available	No data available
Carnosaur 3: Primal Species	1996	USA	Jonathan Winfrey	No data available	No data available
The Island of Dr. Moreau	1996	USA	John Frankenheimer	$27,663,982	$49,627,779

Movie tittle	Year of release	Country	Director	Box office US	Box office worldwide
Nutty Professor	1996	USA	Tom Shadya	$128,814,019	$273,961,019
Multiplicity	1996	USA	Harold Ramis	$21,075,014	$36 875 014
Gattaca	1997	USA	Andrew Niccol	$12,532,777	$16 132 777
The Relic	1997	US/USA/Japan/Germany	Peter Hyams	$33,956,608	$65,756,608
Parasite Eve	1997	Japan	Masayuki Ochiai	No data available	No data available
Cloned	1997	USA	Douglas Barr	No data available	No data available
Johnny 2.0	1997	USA	Neil Fearnley	No data available	No data available
The Lost World: Jurassic Park	1997	USA	Steven Spielberg	$229,086,679	$618,638,999
The Third Twin (TV movie)	1997	Canada	Tom McLoughlin	Not applicable	Not applicable
Mimic	1997	USA	Guillermo del Toro	$25,480,490	No data available
Alien: Resurrection	1997	USA	Jean-Pierre Jeunet	$47,795,658	$161,376,068
Jack Frost	1997	USA	Michael Cooney	No data available	No data available
DNA	1997	USA/Philippines	William Mesa	No data available	No data available
The Fifth Element	1997	France/UK/USA	Luc Besson	$63,820,180	$263,920,180
Species 2	1998	USA	Peter Medak	$19,221,939	$33, 521,939
Brave New World (TV movie)	1998	USA	Leslie Libman, Larry Williams	Not applicable	Not applicable
Universal Soldier 2: Brothers in Arms (TV movie)	1998	Canada/USA	Jeff Woolnough	Not applicable	Not applicable
Soldier	1998	USA/UK	Paul W.S. Anderson	$14,594,226	$16,994,226
The X-Files: Fight the Future	1998	USA	Rob Bowman	$83,898,313	$189,176,423
Blade	1998	USA	Stephen Norrington	$70,087,718	$131,183,530
Pokémon: The First Movie	1998	Japan	Kunihiko Yuyama	$85,744,662	$163,644,662
Deep Blue Sea	1999	USA/Mexico	Renny Harlin	$73,648,142	$164,648,142
Austin Powers: The Spy Who Shagged Me	1999	USA	Jay Roach	$206,040,086	$312,016,858
Bats	1999	USA	Graeme Revell	$10,155,690	No data available
Jack Frost 2: Revenge of the Mutant Killer Snowman	2000	USA	Michael Cooney	No data available	No data available
Nutty Professor 2: The Klumps	2000	USA	Peter Segal	$123,309,890	$166,339,890
Spiders	2000	Israel/USA	Gary Jones	No data available	No data available
The Other Me (TV movie)	2000	USA	Manny Coto	Not applicable	Not applicable
The 6th Day	2000	USA	Roger Spottiswoode	$34,604,280	$96,085,477

Movie tittle	Year of release	Country	Director	Box office US	Box office worldwide
X-Men	2000	USA	Bryan Singer	$157,299,717	$296,339,527
Replicant	2001	USA	Ringo Lam	$5,700,000	No data available
Shadow Fury	2001	USA	Makoto Yokoyama	No data available	No data available
Venomous	2001	USA	Fred Olen Ray	No data available	No data available
Mimic 2	2001	USA	Jean de Segonzac	No data available	$8,100,000
Jurassic Park 3	2001	USA	Joe Johnston	$181,171,875	$368,780,809
Xchange	2001	Canada	Allan Moyle	No data available	No data available
Evolution	2001	USA	Ivan Reitman	$38,345,494	$98,376,292
No Ordinary Baby (TV movie)	2001	Canada/USA	Peter Werner	Not applicable	Not applicable
Flying Virus	2001	USA/Brazil	Jeff Hare	No data available	No data available
Spider-Man	2002	USA	Sam Raimi	$403,706,375	$821,708,551
The Adventures of Pluto Nash	2002	USA/Australia	Ron Underwood	$4,420,080	$7,103,973
Star Trek X: Nemesis	2002	USA	Stuart Baird	$43,254,409	$67,312,826
Repli-Kate	2002	Germany/USA	Frank Longo	No data available	No data available
Teknolust	2002	USA/Germany/UK	Lynn Hershman-Leeson	$28,811	No data available
Sabretooth (TV movie)	2002	USA	James D.R. Hickox	Not applicable	Not applicable
Blade 2	2002	Germany/USA	Guillermo del Toro	$82,348,319	$155,010,032
Resident Evil	2002	UK/Germany/France/Japan/USA	Paul W.S. Anderson	$40,119,709	$102,984,862
Austin Powers in Goldmember	2002	USA	Jay Roach	$213,307,889	$296,655,431
Star Wars: Episode 2. Attack of the Clones	2002	USA	George Lucas	$302,191,252	$649,398,328
Yesterday (*Yeseuteodei*)	2002	South Korea	Yun-su Chong	No data available	No data available
Blueprint	2003	Germany	Rolf Schübel	No data available	No data available
X-Men United	2003	USA/Canada	Bryan Singer	$214,949,694	$407,711,549
Code 46	2003	UK	Michael Winterbottom	$285,585	$1,788,324
Hulk	2003	USA	Ang Lee	$132,177,234	$245,360,480
Natural City	2003	South Korea	Byung-chun Min	No data available	No data available
Mimic: Sentinel	2003	USA	J.T. Petty	No data available	No data available
Species 3	2004	USA	Brad Turner	No data available	No data available
The Curse of the Komodo	2004	USA	Jim Wynorski	No data available	No data available
Frankenstein (TV movie)	2004	USA	Marcus Nispel	Not applicable	Not applicable

Movie tittle	Year of release	Country	Director	Box office US	Box office worldwide
Blade: Trinity	2004	USA	David S. Goyer	$52,411,906	$128,905,366
Frankenfish (TV movie)	2004	USA	Mark A.Z. Dippé	Not applicable	Not applicable
Spider-Man 2	2004	USA	Sam Raimi	$373,585,825	$783,766,341
Resident Evil: Apocalypse	2004	Germany/France/UK/Canada/USA/Japan	Alexander Witt	$51,201,453	$129,342,769
Boa vs. Python (TV movie)	2004	USA/Bulgaria	David Flores	Not applicable	Not applicable
Godsend	2004	Canada/USA	Nick Hamm	$14,379,751	$30,114,487
The Island	2005	USA	Michael Bay	$35,818,913	$162,949,164
Doom	2005	UK/Czech Republic/Germany/USA	Andrzej Bartkowiak	$28,212,337	$55,987,321
Locusts (TV movie)	2005	USA	David Jackson	Not applicable	Not applicable
Locusts. 8th Plague (TV movie)	2005	USA	Ian Gilmour	Not applicable	Not applicable
Attack of the Sabretooth (TV movie)	2005	USA	George Miller	Not applicable	Not applicable
Æon Flux	2005	USA/Germany/Brazil/Italy	Karyn Kusama	$25,874,337	$52,304,001
X-Men: The Last Stand	2006	USA/UK/Canada	Brett Ratner	$234,362,462	$459,359,555
The Shaggy Dog	2006	USA	Brian Robbins	$61,123,569	$87,134,280
Black Sheep	2006	New Zealand/South Korea	Jonathan King	No data available	$4 947 717
Resident Evil: Extinction	2007	France/Australia/Germany/UK/USA/Mexico/Canada/Japan	Russell Mulcahy	$50,648,679	$148,412,065
The Gene Generation	2007	USA/South Korea/Singapore	Pearry Reginald Teo	No data available	No data available
Black Swarm (TV movie)	2007	Canada	David Winning	Not applicable	Not applicable
Supergator (TV movie)	2007	USA/Japan	Brian Clyde	Not applicable	Not applicable
I Am Legend	2007	USA	Francis Lawrence	$256,393,010	$585,349,010
Species: The Awakening (Video)	2007	USA/Mexico	Nick Lyon	Not applicable	Not applicable
A number (TV movie)	2008	UK/USA	James MacDonald	Not applicable	Not applicable
Splice	2009	Canada/France/USA	Vincenzo Natali	$17,010,170	$26,857,459
Avatar	2009	USA/UK	James Cameron	$760,507,625	$2,787,965,087
X-Men Origins: Wolverine	2009	USA/UK	Gavin Hood	$179,883,157	$373,062,864
Universal Soldier: Regeneration	2009	USA	John Hyams	No data available	$844,447
Moon	2009	USA/UK	Duncan Jones	$5,010,163	$9,760,104
Womb	2010	Germany/Hungary/France	Benedek Fliegauf	No data available	No data available
Mega Piranha (TV movie)	2010	USA	Eric Forsberg	Not applicable	Not applicable

Movie tittle	Year of release	Country	Director	Box office US	Box office worldwide
Never Let Me Go	2010	UK/USA	Mark Romanek	$2,434,652	$9,455,232
Sharktopus (TV movie)	2010	USA	Declan O'Brien	Not applicable	Not applicable
Resident Evil 4: Afterlife	2010	Germany/France/Canada/UK/China/USA	Paul W.S. Anderson	$60,128,566	$300,228,084
I'm Not Jesus Mommy	2010	USA	Vaughn Juares	$15,005	No data available
Rise of the Planet of the Apes	2011	USA	Rupert Wyatt	$176,760,185	$481,801,049
X-Men: First Class	2011	USA	Matthew Vaughn	$146,408,305	$353,624,124
Cloned: The Recreator Chronicles	2012	USA	Gregory Orr	No data available	No data available
Resident Evil: Retribution	2012	France/Canada/Germany/USA	Paul W.S. Anderson	$42,345,531	$240,004,424
The Amazing Spider-Man	2012	USA	Marc Webb	$262,030,663	$757,930,663
Universal Soldier: Day of Reckoning	2012	USA	John Hyams	$5,460,000	$1,545,188
Errors of the Human Body	2012	Germany/USA	Eron Sheean	No data available	No data available
The Wolverine	2013	USA/UK	James Mangold	$132,556,852	$414,828,246
Oblivion	2013	USA	Joseph Kosinski	$89,107,235	$286,168,572
Spiders 3D	2013	USA/Israel	Tibor Takács	No data available	No data available
X-Men: Days of Future Past	2014	USA/UK/Canada	Bryan Singer	$233,921,534	$747,862,775
The Amazing Spider-Man 2	2014	USA	Marc Webb	$202,853,933	$708,982,323
Teenage Mutant Ninja Turtles	2014	USA	Jonathan Liebesman	$191,204,754	$493,333,584
The Reconstruction of William Zero	2014	USA	Dan Bush	No data available	No data available
The Perfect 46	2014	USA	Brett Ryan Bonowicz	No data available	No data available
Sharktopus vs Pteracuda (TV movie)	2014	USA	Kevin O'Neill	Not applicable	Not applicable
Jurassic World	2015	USA	Colin Trevorrow	$652,270,625	$1,671,713,208
Sharktopus vs. Whalewolf (TV movie)	2015	USA	Kevin O'Neill	Not applicable	Not applicable
Consumed / Food	2015	USA	Daryl Wein	$20,476	No data available
Morgan	2016	USA/UK	Luke Scott	$3,915,251	$8,810,591
Resident Evil: The Final Chapter	2016	Australia/France/Japan/Canada/Germany/RSA/USA/UK	Paul W.S. Anderson	$26,830,068	$312,242,626
Piranha Sharks	2016	USA	Leigh Scott	No data available	No data available
X-Men: Apocalypse	2016	USA	Bryan Singer	$155,442,489	$543,934,787
Teenage Mutant Ninja Turtles: Out of the Shadows	2016	USA	Dave Green	$82,051,601	$245,623,848
Deadpool	2016	USA	Tim Miller	$363,070,709	$783,112,979

Movie tittle	Year of release	Country	Director	Box office US	Box office worldwide
Blade Runner 2049	2017	USA//UK/Hungary/Canada	Denis Villeneuve	$92,054,159	$259,239,658
Logan: Wolverine	2017	USA	James Mangold	$226,277,068	$619,021,436
Okja	2017	South Korea/USA	Joon-ho Bong	No data available	$511,350
Replicas	2018	UK/China/Puerto Rico/USA	Jeffrey Nachmanoff	$4,046,429	9,330,075

Source: https://www.boxofficemojo.com