When do things die?

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to appear in Ben Bradley, Jens Johansson, Fred Feldman, eds., *The Oxford Handbook of Philosophy and Death* (OUP, forthcoming)

Introduction

Many different projects have been pursued under the heading 'the definition of death'. Those who pursue these projects differ in what they are trying to define and in what sense they are trying to define it. Some take their target to be a notion of death that applies only to human beings or only to persons.[1] Some try to 'define' their target merely in the epistemic sense of specifying a reliable and easily detectable mark or indicator of it.[2]

This chapter pursues a more general and metaphysical project. My central target will be *dying*, the concept (or property or relation) expressed by the verb 'die' as it occurs in sentences in the perfective aspect, such as 'Mary died at midnight'. I assume that this is a general biological concept that applies univocally across a wide range of entities, including human beings, cats, trees, bacteria, and individual cells (e.g., human skin cells) that are not organisms. These things all die, in the same sense of 'die'. My main concern in the chapter is not to define the word 'die' or to analyze the concept it expresses. Rather, it's the project of giving informative, metaphysically necessary and sufficient conditions for a thing to die at a time. In particular, it's the attempt to formulate a true and informative instance of the following schema:

S Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if _______.[3]

Each instance of S can be thought of as an answer to the question, "When does a thing die?"[4] One natural answer is, "when it stops being alive." This corresponds to an instance of S that I dub the *Cessation Thesis*:

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[1] See DeGrazia (2005), (2008) and Lizza (2006) for discussion and many further references.

[2] This epistemic project is often called 'giving *criteria* of death'. For helpful discussion of the different things that have been meant by 'defining' in the so-called 'definition of death' literature, see Feldman (1992: 12-18), Fischer (1993: 3-8), and Belshaw (2009: 16-28).

[3] Instances of S try to spell out the conditions for dying *at an instant*. The restriction to instants is important, since things may die also at entities that are not instants, and the conditions for dying at a non-instant may be quite different from those for dying at an instant. E.g., it may be that if a thing dies at an instant t, then it also dies at any extended interval of time that includes that instant. And it may be that things die at places ('he died at the top of Mt. Shasta') and at spacetime regions that are not instants. If so, this would make it extremely difficult to formulate a true and informative instance of the unrestricted schema 'necessarily, for any x and any y, x dies at y iff ____.' The only way to make the project even remotely manageable is to focus on S instead of the unrestricted schema.

[4] Those philosophers who take themselves to be asking a question framed in terms of a notion of death that applies only to people or to humans (DeGrazia 2008) might instead be construed as trying to formulate a true and informative instance of a different schema, namely:

S_H Necessarily, for any x and any t, if t is an instant and x is a human being [*simpliciter* or, alternatively, *at some time*], then x dies at t if and only if ___________.

So construed, their question is framed in terms of the very same (general, biological) concept of death as is my question, but their question is *narrower*: not 'when do *things* die?' but 'when do *humans* die?' Perhaps this narrower question admits of a more informative, more precise answer than does the broad question that I ask here. See the final two paragraphs of section 5 for more on this.

CT Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if x ceases to be alive at t.[5]

CT does not purport to specify the meaning of the word 'dies' or to be an analysis of the concept expressed by that word. One can endorse CT even if one holds that (i) the given concept is simple and unanalyzable or that (ii) the concept does have an analysis but not one that involves the concept of being alive. Likewise, one can endorse CT even if one holds that the sentence 'if John died at noon, then he ceased to be alive at noon' is not analytic. What the Cessation Thesis says is merely that there is a metaphysically necessary connection between dying and ceasing to be alive.[6] Whether any of the relevant concepts have analyses is a separate question.

Here is an analogy noted in a similar context by Ned Markosian (1998: 214-215). One can give an answer to Peter van Inwagen's Special Composition Question ('Under what conditions do some things compose something?') without thinking that one's answer constitutes an analysis of the concept of the composition or a definition of the word 'compose'. For example, van Inwagen himself endorses the following answer to the Special Composition Question: (VIPA) necessarily, for any xx, there is something that xx compose if and only if the activities of xx constitutes a life. (Here 'xx' is used as a plural variable.) But VIPA is not an analysis of the concept of composition. That concept can be analyzed as follows:

xx compose y at t =df. (i) no two of xx overlap at t, (ii) each of xx is a part of y at t, and (iii) each part-at-t of y overlaps-at-t at least one of xx,

where 'x overlaps y at t' is defined as '∃z[z is a part of x at t & z is a part of y at t]'. Composition is a purely mereological concept, one whose analysis involves only logical and mereological notions. Rather than analyzing the concept of composition, VIPA aims to specify certain metaphysically necessary connections between that concept and other concepts that are not involved in its analysis. One might take a parallel view about CT and dying. One might think that while CT is true, the analysis of the concept of dying does not involve the concept of being alive, but rather runs something like this:

x dies at t =df. x becomes dead at t,

[5] In response the question, 'When does a thing die?', one might say, 'It depends on what kind of thing it is'. One could fill in the details by formulating an instance of the following schema:

$Series_D$ Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if either: x is a K_1, and φ_1, or x is a K_2, and φ_2, or . . ., or x is a K_n, and φ_n.

Here is a silly example of an instance of $Series_D$:

$Series_1$ Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if: either (i) x is a human being and x's heart and lungs cease irreversibly to function at t, or (ii) x is a tree, and x falls down at t.

The example is silly because it's obviously false. I had a cat that died at a certain instant, but since it was neither a human being nor a tree, it generates a counterexample to $Series_1$. Less silly instances would need to have enough clauses so that everything that can die falls under at least one of those clauses. I have no objection to such principles, but I wouldn't know how to begin formulating one (in which the separate clauses for different kinds of things did real work). See Markosian (2008: 354-355) for a discussion of 'series-style' answers to the 'special composition question': under what conditions do some things compose something? I take the 'series' terminology from him.

[6] Strictly speaking, it doesn't even say this. A proponent of CT could consistently deny the existence of concepts, properties and relations.

where the concept of being dead is unanalyzable. I want to leave this analysis open. (For more on this, see note 24.)

Enough about CT for now. The plan for the chapter is as follows. In sections 2 and 3 I discuss a pair of problems for CT – one arising from suspended animation, the other arising from fission – and I consider a series of repairs. Unsurprisingly, none of the repairs is completely satisfactory. We shouldn't assume that informative, individually necessary, jointly sufficient conditions for dying at a time (or for any ordinary concept) are likely to be had. On the other hand, we shouldn't assume from the outset that this is an unattainable or unworthy goal, or that there is nothing interesting to learn by pursuing it. Though it may be predictable *that* our attempts to formulate such an account will fail, I doubt that anyone will pretend to know in advance exactly *what* the most plausible accounts are or exactly *why* they fail, if they do. Succeed or fail, the project ought yield a clearer picture of the distinctive 'modal profile' of dying.

With an (imperfect) account of dying in place, section 4 takes up a different question: When are things *dead*? The question is harder than one might think, but it's easier than 'When do things die?' and can be dealt with more quickly.

1. Preliminaries

Before we get started, it will be convenient to introduce some of the expressions, concepts, and doctrines that will be in play.

1.1 Presentism and Eternalism

These are rival views about the ontology of time. Roughly put, presentism is the view that the only things that exist or are real are the present time and its contents, and eternalism is the view that past, present, and future times and their contents all exist equally.[7] Just as Neptune exists despite being far away in space, eternalists say, Pangaea and the 2086 NBA scoring champion both exist despite being 'far away in time'. (Presentists, by contrast, say that Neptune exists but Pangaea and the 2086 NBA scoring champion do not.[8]) Given eternalism, we will need to draw a distinction between the ontological notion of *existing*, on the one hand, and the locational notion of *existing at* or, as I will say, *being present at*, a time, on the other. Pangaea exists, according to eternalists, but it is not present at any instant in the year 2010; rather, it is present only at pre-Cenozoic instants. Intuitively, a thing is present at a time just in case part of its career occurs at that time.

Presentists and eternalists both agree that Neptune is *present at* the current time and that Pangaea is not, and they both agree that Neptune *exists*. They disagree about whether Pangaea exists: eternalists say that it does, and presentists say that it does not. Throughout the chapter, I assume that eternalism is true, though most of what I say can probably be reframed in presentist terms, at the cost of some awkwardness. I also assume that there are such things as instants, and that time is a continuum of them.[9]

[7] These are not the only alternatives. There is also, e.g., the Growing Block view, according to which the past and present exist but the future does not, and reality grows as time passes. See Dainton (2010) for a detailed discussion of all these views.

[8] Presentists invoke primitive tense operators such as 'it was the case that' and 'it will be the case that' to capture facts about how things were and will be. Thus they can say 'Pangaea does not exist' and 'it was the case that Pangaea exists'.

[9] This is standard but not uncontroversial; there are a number of alternatives. First, one might think that time is 'gunky', so that there are temporally extended intervals (each of which is composed of briefer but still temporally extended sub-intervals) but no temporally unextended instants (Artzenius 2008). Second, one might think that time is 'grainy' and so composed of minimal units that do not sub-divide further, but each of which is temporally extended (Braddon-Mitchell and Miller 2006). Third, one might be a relationist about time and deny the existence of temporal locations of any sort, be they intervals, instants, or extended 'grains'. (See Hawthorne and Sider 2006 for discussion.) Finally, one might doubt the existence of instants on the grounds that spacetime,

1.2 The Termination Thesis

This is the view that

TT for any x and any instant t, if x dies at t, then x ceases to be present at t.[10]

Those who endorse the Termination Thesis – *Terminators* – will say that when Lenin died, he ceased to be present and hence is presumably not contained in his display case in Red Square now.[11] What does that display case contain, according to Terminators? The two most natural options are: (i) a human-shaped object that began to be present when Lenin died and that is composed of (mostly) the same particles that composed Lenin at the end of his life, or (ii) some particles that are 'arranged corpse-wise' but that do not compose anything at all. We might call the former *Lenin's corpse* and the latter *Lenin's remains*.

Some friends of the Termination Thesis may wish to say that the things that *die* (people, organisms, what have you) are *constituted by* but not *identical to* certain other material objects (bodies, portions of matter, what have you). Further, they may wish to say that, typically, when a person or organism dies, the thing that constitutes it in the final moments of its life typically does not cease to be present. On this view, when Lenin died, he ceased to be present, but the thing that constituted him in the final moments of his life did not cease to be present. Perhaps, then, what Lenin's display case contains is something that once constituted Lenin (but was never identical with him), namely, his body. Together with the Termination Thesis as stated, this view entails that

L Lenin's body did not die when Lenin died.

L may seem surprising, since one would think that Lenin's body was characterized by the same distribution of intrinsic physical properties as was Lenin over those final moments, and that it stood in the same spatial and causal relations to other things as Lenin did. And it's tempting to think that when two things are alike in these ways, they are also alike in whether they die at the given time. But for Terminators who are willing to reject the relevant 'supervienience-of-dying' principle, L is available.

However, anyone who thinks that Lenin's display case contains something that died in 1924 (Lenin, a body, an organism) will want to reject the Termination Thesis, as I have framed it.[12]

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rather than space and time, is the fundamental 'spatiotemporal arena'. One might think that instants exist only if they are parts of spacetime, and one might think that something about the geometric structure of spacetime prevents any of its parts from counting as instants (Gibson and Pooley 2006: 160; Lockwood 2005: 152).

[10] Without using 'ceases to', we might try: for any x and any instant t, if x dies at t, then there are continuous intervals I and I* such that: (i) I immediately precedes t, (ii) x is present at each instant in I, (iii) I* immediately follows t, and (iv) x is not present at any instant in I*. (A continuous interval I *immediately precedes* an instant t iff t is the *end point* of I, i.e., iff no instant in I is later than t, and there is no instant t* that is later than each instant in I but earlier than t. A continuous interval I *immediately follows* an instant t iff t is the *starting point* of I, i.e., iff no instant in I is earlier than t, and there is no instant t* that is earlier than each instant in I but later than t. Closed intervals include their starting points and end points. Open intervals include neither. Partially open intervals include one but not the other.) However, if John is present throughout the first half hour following 11:00 am, then non-present throughout the next 15 minutes, then present throughout the next 7.5 minutes, then non-present throughout the next 3.75 minutes, and so on, and if John is not present at any instant after noon, one might be tempted to say that John *ceases to be present* at noon, even though he not present throughout any continuous interval that immediately precedes noon.

[11] The Termination Thesis is accepted by Hershenov (2005), Johansson (2005: 45), Luper (2009: 46-47), Merricks (2001: 151), Olson (2004), Rosenberg (1998: 50), and Yourgrau (2000: 49). It is rejected by Belshaw (2009: x), Carter (1999), Feldman (1992: 89-105) and (2000), Mackie (1999), and Thomson (1997). See Johansson (2005: 45) for further names and citations.

[12] There is a different, weaker thesis in the neighborhood that may have some claim to the title 'The Termination Thesis', namely,

Likewise for those who think that trees often remain standing for several years after they die. Most of what I will say in this chapter should in principle be acceptable both to friends and to foes of the Termination Thesis, though, for what it's worth, I tend to sympathize with its foes.

One final point about the Termination Thesis before we move on. I have stated it in terms of dying and presence. But it is typically stated in terms of dying and existence, roughly as follows:

TT* Things cease to exist when they die.

TT* might be read just as a more colloquial formulation of TT, in which case I have no complaints about it. But it might instead be given a second reading that puts it in tension with eternalism. On the second reading, TT* entails that if Socrates has died (and has not somehow begun to exist again in the interim), then *there is no such entity as Socrates*, where this is not merely a matter of Socrates's temporal location but is a matter of ontology. Eternalists want to say that, like all past, present, and future things, Socrates *exists* (at least in a tenseless sense) and has never *ceased* to exist, though of course they will add that he does not bear the <u>being present at</u> relation to any instant in the year 2010. Eternalists also want to say that Socrates died. So they will need to reject TT*, on its second reading.

But it seems to me that the intuitive idea that philosophers have in mind when they use the label 'The Termination Thesis' is an idea that can be accepted by presentists and eternalists alike. It is a view about things that live and die, and about their relationship to time. Roughly put, it is the view that a thing 'ends' when it dies; it does not keep persisting as a dead thing after it dies. This view is neutral with respect to debates about the ontology of time, as is TT, my formulation of the Termination Thesis. By contrast, TT*, on its second reading, is not neutral in this way, which makes me think that it shouldn't be identified with the Termination Thesis.

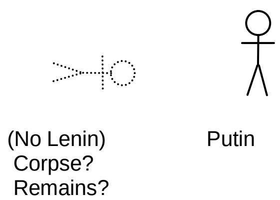
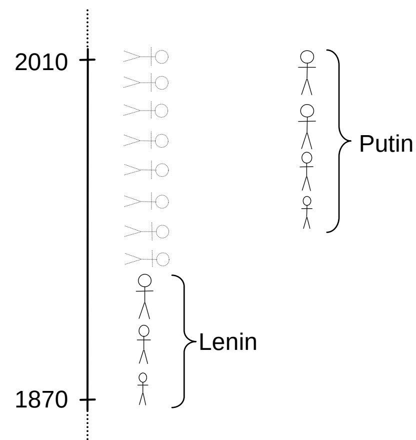
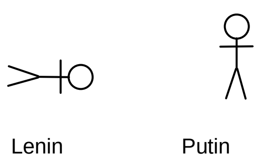
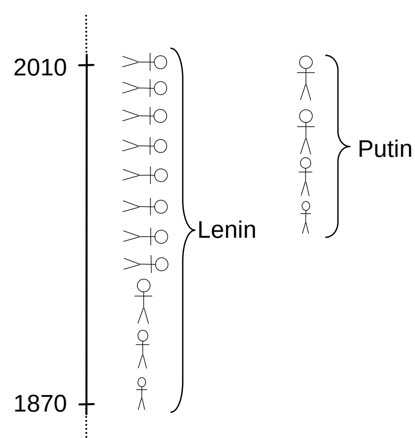
The interaction between the dispute over the Termination Thesis and the dispute between presentism and eternalism is summarized in figure 1.[13] The diagram adopts the simplifying assumption that opponents of the Termination Thesis ('anti-Terminators') will say that *people* typically remain present for a while after they die. But not all anti-Terminators will really want to say this. Some of them will say that Lenin and his body both died at the same time, and that Lenin ceased to be present then but his body did not.

Having introduced a pair of metaphysical controversies relevant to philosophical questions about death, I turn now to six expressions that will play a role in subsequent discussion (or that are easily confused with those that will).

TT_r For any x and any instant t, if x is a *person* [alternatively, *human person*; alternatively, *one of us*, whatever we are] and x dies at t, then x ceases to be present at t.

Whereas TT says that for any entity x whatsoever, if x dies at t, then x ceases to be present at t, TT_r says merely that *people* cease to be present when they die. Accordingly, the friend of TT_r is free to say that Lenin's body died but did not cease to be present in 1924, provided that she holds that Lenin's body is not person. Baker (2000: 120) defends essentially this view.

[13] Figure 1, and indeed the entire chapter, should be understood as being neutral on the dispute between endurantism and perdurantism. Endurantism, roughly, is the view that if x is a material object then x is (i) temporally unextended and (ii) 'wholly present' at each instant at which it is present. Perdurantism, roughly, is the view that if x is a material object, then x has a different temporal part at each different instant at which it is present. See Balashov (2011), Hawley (2010), and Sider (2001a) for more careful formulations of these and other views about persistence.

	Presentists say: things cease to exist when they cease to be present	**Eternalists** say: things do not cease to exist when they cease to be present
Terminators say: things cease to be present when they die	Things cease to exist when they die Reality (i.e., reality now) 	Things cease to be present but don't cease to exist when they die Reality 
Anti-Terminators say: things at least sometimes remain present for awhile after they die	Things at least sometimes remain present, and hence keep existing, for a while after they die, but as soon as they cease to be present, they cease to exist Reality (i.e., reality now) 	Things at least sometimes remain present for a while after they die, and they don't cease to exist when they cease to be present Reality 

1.3 'is alive'

I won't try to define the adjective 'alive', analyze the concept it expresses, or give informative necessary and sufficient conditions for being alive. These tasks are too much for a single chapter, not to mention one whose main focus is on death. Instead, I'll assume that, as with most ordinary concepts, we grasp the concept of being alive even in the absence of anything like an analysis of it. My project here is not to shed new light on being alive, but rather to *use* this concept to shed light on death. I think the reader will agree (at least by the end of the chapter) that even if the concept of being alive were crystal clear and perfectly understood, either as a primitive or via one's favorite analysis, there would still be hard and interesting questions about the *connections* between being alive and dying. Those connections are among the topics to be explored here.

As with 'dies', my default assumption is that 'alive' is not context sensitive. To see the significance of this assumption, suppose that a biologist is giving a lecture about the flora of California to a group of tourists. She points to a bristlecone pine and utters the sentence, 'Surprisingly, that tree is alive'. Now suppose that two paramedics arrive at the scene of a car accident. One of them rushes to a victim lying motionless in a ditch, checks the victim's pulse, and shouts, 'He's alive!'. According to the 'no context sensitivity' assumption, 'alive' expresses the same concept (or property or relation) in both contexts.

I take this concept, like the one expressed by 'dies', to apply to a wide range of biological entities, including not just organisms (particular human beings, trees, amoebas, bacteria, . . .) but also individual cells that are not organisms. Being alive, on this view, does not by itself entail having a properly functioning brain or having a properly functioning heart. Bacteria are alive but don't have hearts or brains.[14] Whether the concept applies to biological entities that are neither organisms nor cells – such as organs, organelles, and viruses – I leave open. (The same goes for 'dying', 'dead', and 'a death': my default assumption is that none of these is context sensitive and that each of them expresses a general biological concept that can apply equally to human beings, blood cells, and many things in between.)

Presumably, whether a thing is alive at a given time is a matter of what sorts of physical and chemical processes its parts are engaged in at that time.[15] I take it, in other words, that a thing is alive at a given time just in case it is performing the right sorts of 'life-functions' or 'vital processes' at that time. This much seems relatively uncontroversial, but as soon as one tries to say anything more precise and informative about what the *right sorts* of life-functions are, one encounters difficulties.[16] So I will leave this task to others.

Earlier I noted that there is controversy about whether things cease to be present when they die. One assumption that I take to be shared by all participants in that controversy is that

P1 necessarily, for any x and any t, if t is an instant and x is alive at t, then x is present at t.

According to P1, things are present when they're alive. P1 may seem too obvious to be worth mentioning, but in fact it captures an important respect in which being alive differs from being dead (and being famous). A thing can be dead at an instant at which it's not present; it cannot be alive at such an instant.

Finally, it will be convenient to speak of a dyadic relation 'associated' with being alive: the relation <u>being alive at</u>. A thing can bear this relation to certain times and fail to bear it to others. Lenin bears it to each of the instants in 1923 but to none of the instants in 1925. More generally, I assume that, necessarily, a thing x bears <u>being alive at</u> to an instant t just in case x is alive at t. So much for 'alive'.

1.4 'dies'

To die at an instant is to undergo a certain sort of *transition* then. Can we specify the nature of this transition in a more informative way? It is natural to think that, at least *typically*, a thing x dies at an instant t

- if and only if x ceases to be alive at t,

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[14] Likewise, one should deny that being alive entails having a soul unless one is prepared to say that plants and red blood cells have souls.
[15] Though see note 25 on maximality constraints.
[16] See van Inwagen (1990), Feldman (1992), Hoffman and Rosenkrantz (1997), Boden (1999), Cleland and Chyba (2002), and Luper (2009) for sophisticated discussions and a path into a very large literature.

- if and only if x becomes dead at t, and
- if and only if a death of x culminates[17] at t.

Whether each of these biconditionals holds in full generality is a difficult question. We will have much more to say about the first of these in sections 2 and 3.

A number of further questions naturally arise concerning the connections between the concept expressed by ‘dies’ and those expressed by ‘alive’ and ‘present’: Can a thing be alive at an instant at which it dies?[18] Can it *fail* to be alive at such an instant?[19] Can a thing be *present* at an instant at which it dies?[20] Can a thing *fail* to be present at such an instant?[21] For reasons given in the notes, I think our default answer to each of these questions should be ‘Yes’.

Some may balk at the claim that things die at *instants*. It is hard to know *precisely* when a thing dies, and not merely because we lack detailed information about a thing’s physiological processes. Consider a particular death – Nixon’s, say. No matter how complete and detailed our knowledge of the biochemical details in this case, we would still be unable *know*, of any independently identified instant t, that Nixon died at t (and not a femtosecond earlier or later). One might be tempted to infer from this that, strictly speaking, Nixon didn’t die at any instant, but only at some extended interval. Indeed, one might generalize, and say that things typically die only at intervals, not instants. (Such a doctrine might seem to harmonize with the slogan that ‘death is a process, not an event’.)

I think this would be a mistake. In the first place, such a view wouldn’t make it any easier to know the facts about when Nixon died. It would be just as hard to know which precisely demarcated *interval* or *intervals* were the ones at which Nixon died as it would be to know which *instant* was the one at which he died. Second, the most we can confidently infer from our observations about Nixon is that whether a thing dies at a given instant t (as opposed to some nearby instant) is often a *vague* matter. And there is no easy argument from the claim that

(a) each instance of the schema ‘The unique instant at which Nixon died is the one that is exactly ___ seconds earlier than midnight EST, Jan. 1, 2000’ is either vague or false,

to the claim that

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[17] Parsons (1990: ch. 9) gives an account of the perfective aspect according to which the logical form of

(1a) Mary died

is given by

(1b) ∃e∃t [IS A DYING(e) & THEME(e, Mary) & CULMINATES(e, t) & t<now].

Informally, (1b) says: there is an event e such that: (i) e is a dying event, (ii) Mary plays the ‘theme’ role in e, (iii) e culminates at some instant t that is earlier than now. ‘Culminates’ does not just mean ‘ends’, since a dying event might occur, and end, without ever culminating. According to Parsons, this happens when a thing is in the process of dying for a while but then recovers: there is a dying event that goes on for a while and comes to an end without culminating.

[18] Suppose that the interval occupied by John’s life is continuous and topologically closed at its later end, so that there is a *last* instant at which John is alive – call it *t1* – but no *first* instant at which is no longer alive. Suppose also that John goes *directly* from being alive to being dead, so that for some instant *t2* after t1, he is dead at each instant between t1 and t2 (and presumably at t2 and thereafter as well). Then he dies at t1, an instant at which he is alive. After all, I take it that the only other candidates (for being instants at which John dies) are later instants, but for each such instant t, John is dead at t and throughout some temporally extended interval leading up to t, which is a sufficient condition for not dying at t. (If you’re dead at t and have been for awhile, you don’t die at t.)

[19] Suppose that Mary is alive at each instant in some interval leading up to t but that she is dead, not alive, at t and at each instant thereafter. Then presumably she dies at t, an instant at which she is not alive.

[20] In the case described in note 18 above, John dies at t1, an instant at which is he alive and (given P1) present. Moreover, even friends of the Termination Thesis can accept the possibility of this case, provided that they think that a thing can be present at an instant at which it ceases to be present.

[21] We might augment the case described in note 19 above by stipulating that Mary is present only at those instants at which she is alive. This will yield the result that she is not present when she dies.

(b) the sentence ‘there is exactly one instant at which Nixon died’ is either vague or false.

For even if (a) is true, one might think that the reason *why* it’s true is just that there is vagueness as to *which* instant was the unique instant at which Nixon died. In that case, many will say that it is still true and non-vague that Nixon died at *some* – indeed, exactly one – instant, and hence that (b) is false.[22]

Granted, there may be better arguments for (b), and presumably there is a coherent view according to which things die only at extended intervals, rather than at instants. But to keep things simple, I will assume for the remainder of the paper that things die at instants. I take no stand on whether they *also* die at intervals. Finally, I will assume that, necessarily, a thing dies at a given instant just in case the thing bears the dyadic relation dies at to that instant.

1.5 ‘is dying’

Consider the concept expressed by the verb ‘die’ as it occurs in sentences in the *progressive* aspect, such as ‘Mary was dying at midnight’. To a very crude first approximation, a thing x is dying at an instant t if and only if x is alive at t but is involved in some process at t that, if allowed to continue without interference, would soon cause x to die.[23] A thing cannot *die* at an instant unless it becomes dead then, but it can *be dying* at an instant without becoming dead then. Indeed, a thing can be dying for a while but then fully recover and go on to live for many years. (Presumably it is *metaphysically possible* for a thing to be dying for a while and then go on to live for infinitely many years thereafter, and never die.) I assume that, necessarily, a thing is dying at a given instant just in case the thing bears the dyadic relation being (in the process of) dying at to that instant.

1.6 ‘is dead’

Typically, a thing is dead at an instant if and only if the thing died at some earlier instant (or perhaps at t itself, depending upon x’s condition then).[24] I assume that, necessarily, a thing is dead at an instant

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[22] Epistemicists about vagueness can say this, as can supervaluationists, though this fact is often treated as a vice of the latter theory. Moreover, it would seem that those who see some form of ontic indeterminacy at work here could say the same. See Williamson (1994) for more on these views.

[23] Feldman defines ‘x is dying at t’ as follows:

> process P is terminal for organism x =df. x is of some kind, K, such that (1) P is a causal process; (2) P can be broken down into a number of stages, each of which (other than the last) is the loss or decrease of a property that is vital for K; (3) P’s last stage is the death of x; and (4) P contains no covert external linkages. . . .
>
> x is dying2 at t =df. at t, x is engaged in a process that would be terminal for x, if it were allowed to reach its conclusion without interference. (1992: 84)

Parsons (1990: ch. 9) gives an account of the progressive aspect according to which the logical form of

(2a) Mary was dying

is given by

(2b) ∃e∃t[IS A DYING(e) & THEME(e, Mary) & HOLDS(e, t) & t<now].

Informally, (2b) says: there is an event e such that: (i) e is a dying, (ii) Mary plays the ‘theme’ role in e, (iii) e occupies a stretch of time that includes some instant t that is earlier than now. Thus, the difference between

(1a) Mary died

and its ‘progressive correlate’, (2a), is explained in terms of the difference between *culmination* and *holding*. See note 17.

Parsons (1990: ch. 9) and Szabó (2004) discuss various attempts to analyze progressive sentences in terms of their perfective correlates. Both express pessimism about such attempts. Szabó proposes a ‘reverse analysis’, which explains the truth conditions of simple perfective sentences such as (1a) in terms of their progressive correlates, such as (2a). See also Szabó (2008).

[24] Parsons (1990: ch. 10) gives an account of adjectives according to which the logical form of

(3a) Mary was dead

just in case the thing bears the dyadic relation being dead at to that instant. Moreover, I assume that being dead at and being alive at are *incompatible* in the sense that nothing can bear both of these relations to the same instant. Nothing can be both dead and alive at the same time.

Many things, however, are neither alive nor dead at a given time: Pangaea, e.g., is neither alive nor dead at this time. It's not even present now. Further, there are many things that are neither alive nor dead at instants at which they are present: my wallet was present at each instant in the year 2009 but was neither dead nor alive at any of them. (Later I'll give arguments that support similar claims about organisms.) In sum, being alive at and being dead at are *contraries*: they exclude each other but, unlike *contradictories*, the absence of one does not entail the presence of the other.

Finally, I assume that being dead at is quite different from relations such as being bent at or being 2 kg in mass at. Instead, it is more like being an ex-convict at, being ten miles from the North Pole at, and being famous at. Roughly speaking, whether a thing x bears being bent at to an instant t depends only on what x is like in itself at t and is independent of how x is related to things outside itself at t, as well as being independent of how things are at other instants. By contrast, whether a thing x bears being ten miles from the North Pole at to an instant t depends upon how x is related to something outside itself (the North Pole) at t, and whether x bears being an ex-convict at to t depends upon how things are at other times: it depends upon whether x was a convict at a time earlier than t. This is all very loose and impressionistic, but it points toward an intuitive distinction among dyadic relations to instants. Call those that are like being bent at *intrinsic**; call the others *non-intrinsic**.

As an aid to grasping this distinction, some may find it helpful to think in terms of the following rough-and-ready test. To determine whether R is intrinsic*, ask the following questions:

- Is R a dyadic relation that a thing can bear to an instant?
- Must a thing be *present* at an instant in order to bear R to that instant?
- Is it metaphysically possible that: (i) there is a thing x that bears R to an instant t, even though (ii) t is the only instant that exists, (iii) there is nothing before or after t, and (iv) x and its parts are the only things (other than t itself, perhaps) that are present at t?

If the answer to any of these questions is 'No', then R is probably not intrinsic*. If the answer to each of them is 'Yes', then R is probably intrinsic*. So much for the notion of an intrinsic* relation in general. How does this notion apply to the specific relations that interest us here?

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is given by

(3b) ∃s∃t[IS A BEING-DEAD(s) & THEME(e, Mary) & HOLD(s, t) & t<now]

Informally, (3b) says: there is a token state s such that: (i) s is a token of the type *being dead*, (ii) Mary plays the 'theme' role in s, (iii) s occupies a stretch of time that includes some instant t that is earlier than now.

As Parsons (1990: 111) notes, the verb 'die' is typically classified as an *inchoative* (an intransitive verb that has the meaning 'become adj', for some associated adjective) whose associated adjective is 'dead'. On this view, 'die' means 'become dead'. When this view is combined with Parsons's account of inchoatives, we get the result that the logical form of

(1a) Mary died

is given by

(1c) ∃e∃t[CULMINATES(e, t) & THEME(e, Mary) & ∃s[IS A BEING-DEAD(s) & THEME(s, Mary) & HOLD(s, t) & BECOME(e, s) & t<now]]

(1c) purports to be a *more refined* account of the logical form of (1a) than is (1b). Informally, (1c) says that there is an event e, an instant t, and a token state s such that: (i) e culminates at t, (ii) Mary plays the 'theme' role in e, (iii) s is a token of being dead, (iv) Mary plays the 'theme' role in s, (v) s occupies a stretch of time that includes t, (vi) e is an event of something's *coming to be in* token state s, and (vi) t is earlier than now.

Being alive at *might* be intrinsic*; this is a hard question.[25] Likewise for being (in the process of) dying at. But being dead at is clearly non-intrinsic*. A thing cannot be dead at an instant t unless it died at some earlier instant (or perhaps at t itself). Whether a thing is dead at a given instant, then, is a partly *historical* matter; it is partly a matter of how things are at earlier times. Moreover, being dead at, like being famous at, is a relation that a thing can bear to an instant at which the thing is not present. Let t be some instant in the year 2010. Then Socrates is dead at t. (He's also famous then.) But even if he remained present for a while after he died, his is almost[26] certainly not present at t.

Both friends and foes of the Termination Thesis (TT) ought to agree on all of this. However, if we drop TT and assume that some things remain present for a period of time as dead things after they die, we can provide an especially vivid illustration of the fact that being dead at is not intrinsic*:

> **Lenin and his Body Double**. Lenin is dead but still present at t, an instant in the year 2010. To keep museum visitors happy while Lenin is taken off display for maintenance, curators have constructed a copy of him. The copy is so well-made that, at t, Lenin and his copy are 'molecule-for-molecule duplicates'. In the terminology introduced above, they are both *present* at t, and they bear exactly the same *intrinsic* relations* to t. And yet, since the copy was never alive and never died, it is not dead at t. Lenin and his copy bear all the same intrinsic* relations to t, but only Lenin bears being dead at to t. Hence that relation is not intrinsic*.

Strictly speaking, though, this case is overkill. Regardless of whether TT is true, the points made in the previous paragraph suffice to show that being dead at is not intrinsic*. So much for the adjective 'dead' and its content.

1.7 'is a death'

The word 'death' is used as a count noun in sentences such as 'the executioner oversaw seven deaths last year'. I take it that, so used, it is a predicate of events. In particular, I assume that an entity is a death only if (i) it is an event and (ii) its subject (or 'theme') dies at the instant at which it occurs (or 'culminates'). Moreover, I assume that, necessarily, an entity is a death just in case it has the property being a death. In the cases of the expressions 'alive', 'dies', 'is dying', and 'dead', it is convenient to speak of associated dyadic relations: being alive at, dies at, and so on. In the case of the expression 'a death', I can see no need to speak of an associated dyadic relation: whether a given entity is a death does not vary over time. So I will rest content with the monadic property just mentioned.

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[25] There are two main reasons one might have for thinking that it is not strictly intrinsic*. First, one might think that it is governed by a maximality constraint, according to which a thing x is alive at a given time t only if x is not a proper part (or a 'large, arbitrary' proper part) of some larger thing that is alive at t. If it is governed by such a constraint, then it might be possible for me to be alive now but to have some duplicate that is not alive now because it is embedded in a larger thing (e.g., the mereological sum of the duplicate and one extra skin cell) that is alive now. See Sider (2001b). Second, one might think that whether x is alive at t depends on facts about the accelerations and relative velocities of its constituent particles at that time, and one might think these facts depend upon facts about the positions of these particles at earlier and later times. (Still, these facts will presumably supervene on facts about what's going on in an arbitrarily brief interval encompassing t, and so they are not 'radically extrinsic'.)

[26] Perhaps he is an immaterial soul. Perhaps his body was preserved and has remained hidden in some sheltered place all these years (Luper 2009: 47) or is lying in a museum identified only as 'Athenian 35a'. Perhaps the persistence-and-assimilation conditions for dead things are 'mereological essentialist', so that a thing, once it becomes dead and so long as it remains dead, behaves as if it were a mere portion of matter: it continues to be present just in case all of the relevant matter continues to be present, and it never gains or loses any of its matter. In that case, if the matter that composed Socrates at the moment of his death is still present but widely scattered, and if Socrates has not returned to life since his death, then Socrates himself is still present but widely scattered.

1.8 The singular term 'death'

E.g., 'this chapter is about death' or 'death is something that we all think about from time to time'. So used, this word is a referring term (like 'friendliness' or 'friendship') rather than a predicate (like the count noun 'friend', the adjective 'friendly', or the verb 'befriend'). I assume that it refers to an abstract entity, but it is no easy matter to identify this entity in an independent way.[27] None of the following statements is obviously correct:

(a) death = the property being dead (or the relation being dead at)
(b) death = the property dying (or the relation dies at)
(c) death = the property being (in the process of) dying (or the relation being (in the process of) dying at)
(d) death = the property being a death

After all, it seems that a novel, e.g., can be about *death* without being about the property being dead. Death is scary, but the property being dead isn't. (Thanks to Adam Sennet for this example.) Likewise for each of the other properties and relations mentioned above. These considerations might drive us to postulate yet another abstract entity, the referent of 'death', to put alongside those that we've already recognized. On the other hand, it might be suggested that the given considerations turn on some ambiguity or context-sensitivity in the term 'death'. Perhaps some occurrences of that term refer to being dead, other occurrences of it refer to being a death, and so on. In that case, we might not need to add to our stock of abstracta. I won't pursue this issue here.

2. Cryptobiosis

CT says that necessarily, a thing dies at a given instant if and only if the thing ceases to be alive then. In this section and the next, I discuss a pair of problems for CT.[28]

A first problem for CT is that it conflicts with certain plausible claims about suspended animation or *cryptobiosis*. In particular, it conflicts with the claim that some organisms become, e.g., frozen or desiccated in such a way that they temporarily cease to be alive but do not then die.

The term 'cryptobiosis' was introduced by the entomologist and biochemist David Keilin 'for the state of an organism when it shows no visible signs of life and when its metabolic activity becomes hardly measurable, or comes reversibly to a standstill' (1959: 166). Keilin contrasts cryptobiosis with another form of hypobiosis (slowed metabolism), namely *dormancy*. Dormant organisms retain a detectable metabolism. Cryptobiotic organisms do not. A wide variety of unicellular and multi-cellular organisms undergo cryptobiosis in nature. Especially noteworthy are tardigrades, which form their own phylum. Tardigrades are insect-like animals, usually less than 0.5 mm in length, that have eight legs, a multi-lobed brain, and are 'found in freshwater habitats, terrestrial environments, and marine sediments' (Garey et al. 2007). Tardigrades are famous for their ability to undergo anhydrobiosis, a form of cryptobiosis involving desiccation, and to remain viable in such a state for years.

Some of the most interesting cases of cryptobiosis are ones that have been induced experimentally. Keilin describes experiments carried out by Paul Becquerel in the early 1950s in which already desiccated, anhydrobiotic tardigrades (among other things) were cooled to temperatures

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[27] I.e., other than as *the referent of the singular term 'death'*.

[28] There are three more exotic groups of potential counterexamples to CT (and indeed to each of the instances of S to be considered here) that I won't discuss. The first group involves time travel. If a time traveler disappears at instant t in 2010 and reappears at instant t* in 1776 or 2076, one might think that he ceases to be alive, but does not die, at t. (Also see the rather different scenarios discussed in Sorensen 2005.) The second group of cases involve living things that simply 'pop out of existence' spontaneously, without undergoing any deterioration beforehand. Such a thing might seem to cease to be alive without dying. (Thanks to Ted Sider for this.) I suspect that examples in the first group could be handled by carefully re-framing certain parts of our proposals in terms in terms of 'personal time' (Lewis 1986: 69; Sorensen 2005). I offer no suggestions regarding the second group.

of between 0.008 and 0.047 degrees above absolute zero and successfully revived after about two hours (Keilin 1959: 178-9). One pressing question that arises here is whether the life-processes (e.g., metabolism) of such organisms have completely *stopped* or rather are merely *slowed but still-ongoing*.[29] Keilin forcefully argues that at least in the case of cryptobiotic organisms at very low temperatures, their metabolism and other life-processes have stopped. A number of more recent biologists agree. James S. Clegg, e.g., argues that this conclusion applies not just to organisms at very low temperatures but also to anhydrobiotic organisms in nature:

> I have previously . . . given reasons why one is compelled to conclude that the removal of all but, say, 0.1 g H_2O/g dry weight (easily achieved by anhydrobionts), will inevitably result in the cessation of metabolism. For example, one can calculate that this amount of water is insufficient to hydrate intracellular proteins, without which a metabolism is obviously not possible. . . Central to these matters is the definition of 'metabolism'. It should be appreciated . . . that metabolism is not merely the presence of chemical reactions in anhydrobionts, indeed, those are inevitable at ordinary biological temperatures. It seems reasonable to require that a metabolism must consist of systematically controlled pathways of enzymatic reactions, governed in rate and direction, integrated and under the control of the cells in which they are found. An additional requirement concerns the transduction of free energy from the environment and its coupling to endergonic processes such as biosynthesis and ionic homeostasis (2001: 615).

Now, to see how all this bears on CT, consider a cryptobiotic tardigrade, o, that is frozen at a temperature of just a fraction of a degree above absolute zero, and suppose that it is ametabolic. Everyone agrees that it is alive before it is frozen and after it is thawed and hydrated. But its status while frozen (at time t, say) is more controversial. One might claim that (i) o is still alive at t, that (ii) o is dead at t, or that (iii) o is neither alive nor dead at t. As I mentioned above, I am assuming that being alive at and being dead at are incompatible, so I will ignore the view that such an organism is *both* alive *and* dead. Finally, one might think that the tardigrade's status is a vague or indeterminate matter. In particular, one might think that (iv) the tardigrade is a borderline case of being alive, a borderline case of being dead, but a clear case of not being both-alive-and-dead.[30] (It will be a matter of debate, however, whether and in what sense (iv) is a *rival* to each of (i) – (iii). More on this below.)

Start with (ii), the claim that the tardigrade is dead (Wilson 1999: 101). This is implausible, mainly because of facts about the tardigrade's internal structure: in some sense, the organism is still *structurally intact* and relatively *undamaged*. It still has eight legs, a head, and a body, a brain and other internal organs, all of which are intact. It still has cells, and they presumably still have intact membranes, nuclei, mitochondria, and most of the same macromolecules that they contained before they were frozen, a sufficient proportion of which remain undamaged. Indeed, so far as its parts and their arrangement go, the organism is in good shape. The main change that occurs when it becomes cryptobiotic is that the physical and biochemical activity in the organism largely shuts down. When the tardigrade is eventually thawed and exposed to water, this activity resumes.

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[29] Keilin offers a detailed survey of scientific work on related questions, running from Anton van Leeuwenhoek's observations on cryptobiotic rotifers in 1702 up through the mid-20th century. He reports that 'between 1858 and 1859 members of learned societies and the lay press of Paris were, according to Broca, divided into two hostile groups: the resurrectionists and the anti-resurrectionists', with the former holding that the processes had stopped, and the latter holding that the processes had merely slowed (1959: 159).

[30] Framed in terms of a sentence operator, 'def', for definiteness, this comes to

(iv*) (a) ¬def (o is alive at t) & ¬def¬(o is alive at t) &
(b) ¬def (o is dead at t) & ¬def¬(o is dead at t) &
(c) def¬(o is alive at t & o is dead at t)

The friend of (iv*) may or may not also want to accept

(d) def (o is alive at t ∨ o is dead at t),

which, intuitively put, says that o is a clear case of being either-alive-or-dead.

These facts about the tardigrade's internal structure and behavior make it overwhelmingly natural to say that the organism is still *viable*, that it *can* be alive in the future (whether or not it is alive while cryptobiotic), and that it has the *capacity* and the *disposition* to be alive (under appropriate conditions). Indeed, it can be revived relatively easily, merely by being thawed at room temperature and then hydrated, without first being repaired. (To be sure, some damage may be sustained during cryptobiosis and some of this damage may eventually need to be repaired. But the organism must return to a more active metabolic state *before* it repairs itself.) All of this supports the claim that the cryptobiotic tardigrade is not dead and, relatedly, that it did not die when it became cryptobiotic. Note that this is intended as an argument for the negation of (ii), viz.,

(v) ¬o is dead at t.

It is not intended merely as an argument for the claim that o is not a clear case of being dead, i.e., for the claim that o is at most a borderline case of being dead.[31] Indeed, the given considerations strike me as a *persuasive* argument for (v). Organisms that are intact and undamaged the relevant ways, and that have relevant capacity to resume metabolic activity, are flat-out *not dead*, just as a red shirt is flat-out *not green*.

So let us turn to (i), the claim that the organism is *alive* (Kolb and Liesch 2008; Luper 2009: 44).[32] This also faces problems. Earlier I suggested that a thing is alive at a time just in case it is performing 'the right sorts of life-functions' at that time. *Whatever* those life-functions may be, it seems unlikely that they are being performed by a frozen or thoroughly desiccated cell or multi-cellular organism. Such an entity is not moving, growing, reproducing, repairing itself, or absorbing matter from its environment. If Keilin and Clegg are right, it is completely ametabolic. Assuming that being metabolic at a given time is necessary for being alive at that time, [33] we have a prima facie case for the conclusion that our frozen tardigrade is not alive. This is an argument for the negation of (i), viz.,

(vi) ¬o is alive at t,

not merely for the claim that o is not a clear case of being alive.[34]

Taken together, the arguments for (v) and (vi) yield an apparently stable argument for (iii), the claim that the frozen tardigrade is neither alive nor dead. It is not alive because it is not performing the

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[31] In terms of 'def', this comes to: ¬def (o is dead at t).

[32] Peter van Inwagen seems to lean in this direction as well. He writes:

> I find it attractive to suppose that the cat's life persists even when the cat is frozen . . . Perhaps this description will strike some readers as contrived and tendentious. It is not really essential to my position to suppose that our frozen cat is alive. If someone insists that the frozen cat is not alive, I do not think that he is misusing the word 'alive'. I would say that he was proposing a stipulative sharpening of the meaning of 'alive', which is just what I was doing in the previous paragraph. (1990: 146-147)

I suspect that van Inwagen has a higher credence in (iv) than in (i) and a higher credence in (i) than in (ii) or (iii).

[33] For a defense of this claim, see Boden (1999). The biologist John Maynard Smith writes that

> The maintenance of a living state requires a constant flow of energy through the system. A freeze-dried insect is not alive: it was alive, and may be alive again in the future. Energy must be supplied in either the form of suitable chemical compounds or as sunlight, and in either case atoms are continuously entering and leaving the structure of the organism (1986: 2).

Hoffman and Rosenkrantz (1997: 158, 208), who also quote this passage, agree with Smith. As far as I am aware, neither Smith, nor Hoffman and Rosenkrantz, nor Boden takes a stance on whether cryptobiotic organisms are *dead*. Interestingly, Hoffman and Rosenkrantz hold that living entities cease to be present when they enter suspended animation and that they begin to be present again when they are revived, thus undergoing 'intermittent existence' or what I would prefer to call 'intermittent presence' (1997: 159).

[34] In terms of 'def', this comes to: ¬def(o is alive at t).

relevant life-functions; in particular, it is not metabolizing. It is not dead because it is structurally intact and undamaged in a way that makes it relatively easy for it to be alive in the future: no prior repair is needed. Having offered a positive argument for (iii), we need not give any separate consideration to (iv). Either (iv) is rival to (iii), in which case our argument for (iii) gives us a reason to refrain from accepting (iv), or (iv) is not a rival to (iii), in which case we are free to accept them both if we like. The important thing is the argument for (iii).

Some may be tempted to attack (iii) by appeal to the claim that 'alive' and 'dead' are contradictories. (I expect to hear the words, "if a thing isn't alive, then *by definition* it's dead!".) But we already have independent reason to reject this claim. My wallet is not alive, but it's also not dead. In response, one might attack (iii) by appeal to a weaker principle: for any x, if there is an instant at which x is alive, then for any instant t, either x is alive at t or x is dead at t. But we have independent reason to reject this as well: I am alive at this instant, but there are plenty of instants before my conception at which I'm neither alive nor dead. Finally, the critic of (iii) might appeal to a third, still weaker principle: for any x and any instant t, if x is alive at some instant earlier than t, then either x is alive at t or x is dead at t. This is starting to seem quite ad hoc, but that aside, we will see in section 2.2 that there are independent reasons (arising from 'deathless fission') to reject even this third principle.[35] For now, let me just say that I find the case for (v) and (vi) far more compelling than any of the increasingly ad hoc principles just mentioned. Thus being alive at and being dead at still appear to be contraries, not contradictories. The relationship between them is like that between being red at and being green at; it is not like the relationship between being red at and being non-red at.

Among philosophers, Michael Wreen (1987), Fred Feldman (1992: 60-62, 170-171), Ingmar Persson (1995: 500), and Christopher Belshaw (2009: 9) have all endorsed the view that cryptobiotic organisms are neither alive nor dead, and on roughly the grounds given here. This view has been advocated by biologists too. Here, e.g., is Clegg:

> Consider that an organism in anhydrobiosis lacks all the dynamic features characteristic of living organisms, notably due to the lack of an ongoing metabolism to transduce energy and carry out biosynthesis. In that sense it is not 'alive,' yet neither it is it 'dead' since suitable rehydration produces an obviously living organism. . . [T]he severely desiccated anhydrobiont is indeed reversibly ametabolic and we may conclude that there are three states of biological organization: alive; dead; and cryptobiotic (2001: 615).

Anyone who accepts such a view about cryptobiosis will be forced to reject the Cessation Thesis (CT). To see this, consider a typical cryptobiotic tardigrade, and suppose being cryptobiotic is incompatible both with being alive and with being dead. Then when the tardigrade became cryptobiotic, it *did* cease to be alive (since it was alive throughout some interval that immediately preceded the instant at which it became cryptobiotic) but it did *not* die (since a thing cannot die at an instant unless it becomes dead at that instant). Call this the *cryptobiosis argument*.

To be sure, the argument is not airtight. Not everyone will find it plausible that metabolism is necessary for being alive, or that being viable (in the relevant sense) is incompatible with being dead.

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[35] To anticipate: when an ordinary amoeba divides, it ceases to be present and hence ceases to be alive, but it does not then *die*, and hence is not *dead* at the times thereafter. In an otherwise convincing paper, David Hershenov responds to this view about fission in much the same way as my imagined critic responds to (iii):

> If the living one-celled amoeba didn't die when it divided, then that entails that it is either still alive, or at best, in an indeterminate state of being neither determinately alive nor determinately dead. Since it is admitted that amoebas cease to exist when they divide, it sounds absurd to say that they are not also dead (2006: 113).

As I see it, however, there is nothing 'indeterminate' about the state of cryptobiosis or about the state of being a (non-present) amoeba that divided without dying. Entities in these states are simply neither alive nor dead, just as a yellow shirt is simply neither green nor red: it is not hovering in some indeterminate condition. I don't detect anything absurd about this position.

Future research might undermine the Keilin-Clegg view that cryptobiotic organisms are ametabolic. As things stand, however, the argument strikes me as being quite forceful. It deserves to be taken seriously.

So, for those who are persuaded by it, let us consider some alternatives to CT. If merely *ceasing to be alive* is not sufficient for dying, what is? What more is needed? Feldman's treatment of these questions is very helpful. I end up rejecting his positive view (in section 2.4) and putting forward an alternative (in section 2.6), but his critical discussion of a trio of preliminary accounts merits a summary, so I'll start there.

2.1 Permanence

An initial thought is that the difference between entering cryptobiosis and dying is that when an organism does the former, it ceases to be alive only *temporarily*, whereas when an organism does the latter, it ceases to be alive *permanently*. This suggests:

> Permanence   Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if 'x ceases permanently to be alive at t' (Feldman 1992: 63).

But anyone who is convinced by the cryptobiosis argument will want to reject Permanence as well, as the following case brings out:

> **Shattering**. At t1, Alpha makes the transition from being 'actively alive' to being cryptobiotic. It remains in this condition until t2, at which time it is dropped and shatters. At no time after t2 is Alpha alive or even present again.

If the cryptobiosis argument is correct, then things cease to be alive when they go directly from being 'actively alive' to being cryptobiotic. In that case Alpha ceases to be alive at t1. Moreover, since it turns out that Alpha never becomes actively alive thereafter, friends of the cryptobiosis argument will say that Alpha ceases *permanently* to be alive at t1. So, if they were to accept Permanence, they would be forced to say that Alpha *dies* at t1. But they won't want to say that, since they think that things do *not* die when they go from being actively alive to being cryptobiotic, which is what Alpha does at t1. So they will want to reject Permanence.[36]

2.2 Permanence and Irreversibility

The same example also generates problems for the suggestion that permanently and *irreversibly* ceasing to be alive is necessary and sufficient for dying. This suggestion can be stated as

> P&I   Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if 'x ceases permanently and irreversibly to be alive at t' (Feldman 1992: 64).

Friends of the cryptobiosis argument will say that in the Shattering case, there is no instant at which Alpha ceases permanently and irreversibly to be alive. They will say that it ceases permanently to be alive at t1, when it enters cryptobiosis. If there is any instant at which Alpha becomes '*irreversibly non-living'*, that is plausibly t2, when it is shattered. But it does not *cease* to be alive then, according to supporters of the cryptobiosis argument. By t2, they will say, Alpha had already been in a non-living condition for some time. So at neither instant does it *cease permanently and irreversibly to be alive*. Accordingly, friends of the cryptobiosis argument will see P&I as yielding the bizarre verdict

[36] Feldman (1992: 63-64) offers a somewhat different criticism of Permanence.

that Alpha does not die at either t1 or t2, or indeed at any instant. I take it that they will judge this principle to be unacceptable as a result.[37]

2.3 Irreversibility$_1$: the physical impossibility of living again

A natural fix is to remove the requirement that the time at which the thing ceases to be alive must be the same as the time at which its status as non-living becomes irreversible, and to say that the thing dies at the latter time. Feldman formulates a version of this proposal that entails the following principle:

> IR_1 Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if '(i) x ceases permanently to be alive at or before t, and (ii) at t, it becomes physically impossible for x ever to live again' (1992: 64).

How should the relevant notion of physical impossibility be understood here? I offer the following rough suggestion. Start with a notion of *time-indexed physical necessity*. Say that it is physically necessary at t that so-and-so just in case the conjunction of (i) the laws of nature and (ii) a complete intrinsic description of the past and present relative to t entails that so-and-so.[38] Then say that it is physically impossible at t that so-and-so just in case it is physically necessary at t that *not* so-and-so.

Understood in this way, IR_1 may help with the Shattering case. The organism Alpha did cease permanently to be alive at or before t2, and there may be some plausibility to the thought that at t2, it became physically impossible for Alpha ever to be alive again.[39] Moreover, t2 is apparently the only time in the Shattering case that meets these conditions. So IR_1 may yield the desired verdict here – viz., that Alpha dies at t2 and at no other instant.

However, there are two potential problems for IR_1. First, it will be rejected by those who endorse the possibility of things that die and later return to life. (More on this later.) Second, it may be vulnerable to counterexamples of a different sort. One might think that there could be a once-living, cryptobiotic organism that, purely as the result of some change in its environment, and without undergoing any significant *intrinsic* change at all, becomes such that it is physically impossible for it ever to live again. In such a case, IR_1 would yield the implausible verdict that the organism dies at the relevant instant, even though the organism undergoes no significant intrinsic change at that instant and apparently remains cryptobiotic for some time thereafter. Consider the following case:

> **Deep Space**. A desiccated tardigrade, Delta, rides through deep space on a chunk of rock, when suddenly the stars surrounding it in all directions explode into supernovas. Though the laws of nature are not deterministic, there is a certain instant t such that: (i) Delta is intuitively still cryptobiotic at t and will remain so for some time thereafter, but (ii) at t, it begins to be physically necessary that radiation from the supernovas will permanently destroy Delta before any potentially life-restoring processes reach it. Later, at t*, radiation from the supernovas finally reaches Delta and causes intrinsic changes in it that render it non-viable. Delta remains present for some time thereafter.[40]

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[37] Though if one were willing to say that Alpha dies at a certain time that is not an instant – say, the *fusion* of t1, t2, and the instants between them – this might make P&I seem tenable. Thanks to Jens Johansson for this point.

[38] cf. the formulation of determinism in van Inwagen (1983: 58-64).

[39] If determinism is false. See below.

[40] One might also imagine a case that involves a permanently expanding universe in which, at an instant t, it becomes physically necessary that a certain cryptobiotic tardigrade will be in roughly its then-current intrinsic condition at all times thereafter (presumably for an infinitely long period of time).

As applied to this case, IR_1 says that the tardigrade Delta dies at t. But, to supporters of the cryptobiosis argument at least, this ought to seem incorrect. They will want to say that Delta does not die until the later instant t*.

It is worth noting that IR_1 does not even get off the ground unless one assumes that the laws of nature are not deterministic. For suppose that the laws are deterministic, and let o be an organism that ceases to be alive at t1 by entering cryptobiosis. Further, suppose that o never returns to life thereafter. Then I take it that at t1, it becomes physically necessary that o will never be alive again.[41] After all, in a world with deterministic laws, *everything* about the future is physically necessary (in the sense of being entailed by the past and present together with the laws). So, in such a world, as soon as it becomes *true* that a given thing will never live again, it also becomes *physically necessary*. In such a context, IR_1 does no better than Permanence in dealing with problems about cryptobiosis.

2.4 Irreversibility$_2$: the *internally-grounded* physical impossibility of living again

To cope with cases like Deep Space, Feldman proposes a repair that, he thinks, 'comes pretty close to solving the problem of suspended animation' (1992: 65). The repair entails

> IR_2 Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if '(i) x ceases to be alive at or before t, and (ii) at t, internal changes occur in x that make it physically impossible for x ever to live again' (1992: 65).[42]

In a moment I will make a suggestion about how clause (ii) should be understood. But first, how might IR_2 help in the Deep Space case? At t, the thought goes, Delta became such that it was physically impossible for it ever to live again, but this was not because of any *internal changes* that occurred in Delta at t; rather, it was because of external changes that occurred at t. The tardigrade didn't undergo any significant internal changes then at all. So IR_2 apparently does not say that Delta died at t. This gives it an advantage over IR_1. (Does IR_2 say that Delta *does* die at t*, the instant at which it is made non-viable by radiation? Perhaps. We will return to this question.)

Clarifying Irreversibility$_2$

Now let's look at IR_2 a bit more closely. Clause (ii) says 'at t, internal changes occur in x that make it physically impossible for x ever to live again'. Here is a proposal about how this clause should be understood (or what it should be replaced with).

We can start by defining a *distribution* as a (total or partial) function from real numbers to (perhaps empty) sets of intrinsic* relations. And we can say that a thing x *instantiates* a given distribution f *over* a given interval I just in case: (i) f is a distribution, (ii) I is a continuous interval of time, and (iii) for each real number n and set s, f(n)=s iff s is the set of intrinsic* relations that x bears to the instant in I that is located n minutes prior to the end of I. Loosely speaking, if x instantiates f over I, then when you feed a number n into the function f, that function will spit out the set whose members are all and only the intrinsic properties that x had n minutes before the end of I. If x was not present at the given instant, then the set in question will be empty, since things cannot bear intrinsic* relations to ('have intrinsic properties at') instants at which they are not present.

We can now use these notions to define one further technical term: 'intrinsically biologically hopeless', or just 'hopeless$_{ib}$':

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[41] This can be put more carefully as follows: t1 is an initial boundary point of some interval each instant in which has the property being an instant t such that it is physically necessary at t that o not be alive at any instant later than t.

[42] Feldman's doubts about IR_2 arise from what he takes to be 'the obscurity of the concepts of *internality*, *physical impossibility*, and *life*' (1992: 65-66). I don't find these concepts obscure. I am more troubled by certain other features of IR_2 – namely, the fact that it quantifies over such entities as *changes* and the fact that it invokes the notions of *occurring in* and *making*. I will restate Irreversibility$_2$ in a way that avoids these latter notions.

D1 x is $hopeless_{ib}$ at t =df. (i) t is an instant and (ii) there is some proposition p that states the laws of nature,[43] some interval I leading up to t, and some distribution f such that:

(a) x instantiates f over I, and

(b) necessarily, for any instant t_1, any interval I_1 that leads up to t_1, and any later instant t_2 if (p is true and x instantiates f over I_1), then x is not alive at t_2.

Intuitively, to say that x is $hopeless_{ib}$ at t is to say that x has an intrinsic history leading up to t that, given the laws of nature, guarantees that x is not alive thereafter. In other words, the distribution of x's intrinsic properties (or lack thereof) over some period leading up to t makes it physically impossible for x to be alive after t. Thus, whether or not a thing x is $hopeless_{ib}$ at a given instant t need not be purely a matter of x's intrinsic condition at t itself; it can also depend upon x's intrinsic *history*, prior to t.

It is worth pointing out that D1 does not require that a thing be present at an instant in order for it to be $hopeless_{ib}$ at that instant. To see this, suppose that it's metaphysically impossible for a thing to cease to be present at one time and then become present again later on; i.e., suppose that 'intermittent presence' is impossible. Further, suppose that Socrates ceased to be present at t1, and let t2 be some later instant. Then Socrates is $hopeless_{ib}$ at t2.

For there will be some interval leading up to t2 that includes t1 and, say, just the final few minutes of Socrates's career. Call that interval I_s. Now consider the distribution f_s that Socrates instantiates over I_s, and suppose that t_1 is m minutes earlier than t_2. Then for any n less than m, $f_s(n)$ will be the empty set, since Socrates wasn't present at the instant that occurred n minutes before t_2 and hence did not bear any intrinsic* relations to that instant. But for any n* greater than m, f(n*) will be a non-empty set, since Socrates was present at the instant that occurred n* minutes before t_2 and hence[44] did bear some intrinsic* relations to that instant. Thus the distribution f_s that Socrates instantiates over I_s entails ceasing to be present during the interval over which it is instantiated. Given the impossibility of intermittent presence, nothing can instantiate this distribution over a given interval and then be present (or alive) after that interval. Therefore it is not even metaphysically possible, much less physically possible, for *Socrates* to instantiate that distribution over a given interval and then be alive (hence present) at some later instant.

With the notion of $hopelessness_{ib}$ in hand, we can formulate a new instance of the schema S:

IR_2* Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if: (i) x ceases to be alive at or before t, and (ii) x becomes $hopeless_{ib}$ at t.

This, I suggest, is the best way to capture the intuitive idea underlying $Irreversibility_2$ in explicit terms. At least I am not aware of any formulation that clearly does better on this score.[45]

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[43] This is short for 'p is a minimal, complete statement of the laws of nature' – i.e., p leaves no laws out, and p contains no extraneous material. I assume that any such proposition is *true*.

[44] Presumably <u>being present at</u> is itself an intrinsic* relation, but even if not, it seems plausible that necessarily, if a thing is present at an instant, then thing bears some intrinsic* relation to that instant.

[45] There are a number of closely related principles in the vicinity, and it is not entirely clear to me which of them best serves the purposes of the defender of the intuitive idea of $Irreversibility_2$.

For one thing, in D1, one could rewrite clause (b) as 'necessarily, for any instant t1, any interval I1 that leads up to t1, any later instant t2, and *any y*, if (p is true and y bears R to t1), then y is not alive at t2'. This shifts from *de re* talk of the physical impossibility of *x's* living again after undergoing such-and-such an intrinsic history to *de dicto* talk of the physical impossibility that *there be something* that lives again after undergoing such a history.

To get a feel for the principle, let's return to the Deep Space case. Suppose that the tardigrade was alive at t1, that it became cryptobiotic and ceased to be alive at the later time t2, that (due to extrinsic factors) it became physically impossible for the tardigrade to live again at t, and that the tardigrade was badly damaged by radiation at t*. The tardigrade does not become $hopeless_{ib}$ until t* at the earliest. Nothing about its pre-t* intrinsic history guarantees (given the laws) that it won't be alive later. There are possible worlds governed by the same laws in which that tardigrade goes through qualitatively the same intrinsic history but, because of its more favorable surroundings, manages to return to life again later. Hence IR_2* avoids the result that the tardigrade dies at t.

Does IR_2* say that the tardigrade dies at t*, when it is damaged by radiation? That depends upon whether the tardigrade then becomes $hopeless_{ib}$ – i.e., on whether it then becomes such that its intrinsic history makes it physically impossible for it to live again. And that is not a question that we can usefully pursue here, although we will soon address some related questions.

One small point about IR_2* is worth making before we move on: this principle leaves open the possibility that a thing dies at an instant at which it is not $hopeless_{ib}$. To see this, suppose that Bob is alive at t1, at the later instant t2, and at each instant in between, but not at any instant after t2. Further, suppose that Bob is $hopeless_{ib}$ at each instant after t2, but not at t2 itself or at any earlier instant. Then I take it that Bob ceases to be alive at t2 and that he *becomes* $hopeless_{ib}$ at t2, even though he is not $hopeless_{ib}$ *at* that time. If so, then IR_2* tells us that Bob dies at t2.

Is post-mortem revitalization physically impossible? Necessarily so?

So far I have been trying to get clear about what $Irreversibility_2$ says. I think it is best formulated as IR_2*. Now I want to argue that $Irreversibility_2$ is false.

Dead things tend not to return to life. But must it in every case be *physically impossible* for a dead thing to live again? This strikes me as doubtful. To begin to see why, consider the following story[46]:

> **Restoration**. Beta is an ordinary organism. It begins to be alive at t1, lives a typical life, and at t2, as a result of old age and standard wear and tear, it ceases to engage in metabolism or any other life-functions. The portion of matter that made it up[47] in the moments leading up to t2 then begins to decompose slightly. At t3, before much further decay has had a chance to set in, Beta's remains are frozen and preserved. At t4, scientists begin the delicate process of making these remains viable once again. Without introducing any new matter or removing any of the original matter, the scientists gradually and non-disruptively reverse the damage that has recently occurred. Molecule by molecule, they repair the matter, until it comes to be arranged roughly as it was in the final moments of Beta's life, just prior to t2. At t5, the 'repaired matter' makes up something that is a perfect intrinsic duplicate of *Gamma*, a frozen organism that entered cryptobiosis in the normal way. The repaired matter therefore plausibly makes up something that, like its duplicate, is cryptobiotic at t5. The scientists then thaw the repaired matter. At t6, this matter makes up something that is alive and that has an active metabolism.

For another, instead of requiring, for x to be $hopeless_{ib}$ at t, that x's intrinsic history over some interval leading up to t guarantee the physical impossibility of x's living again (given the laws), one could adopt one of the following requirements:

> -that x's intrinsic condition at t itself guarantee the relevant impossibility (given the laws), or
> -that the distribution of x's intrinsic conditions over an *arbitrarily brief* interval surrounding [alternatively: leading up to] t guarantee the relevant impossibility (given the laws).

[46] This is essentially the same case discussed in Gilmore (2007: 225). Luper (2009: 46-49) discusses a similar case.

[47] The expression 'x makes up y at t' can be defined as '∀z[z overlaps x at t if and only if z overlaps y at t]'.

> Moreover, at no point in this sequence of events is any law of nature violated. On the contrary, there are laws of nature (perhaps different from ours), there is a proposition that states them, and they are 'obeyed' throughout the entire process.

Note that there are certain issues on which Restoration is careful not to take an explicit stand. In particular, it takes no explicit stand on whether Beta dies at any point in the story, and it takes no stand on whether the thing that becomes actively metabolic between t5 and t6 is Beta. More generally, it takes no stand on whether there is something that both: (i) ceases to engage in metabolism at t2 and (ii) begins to engage in metabolism between t5 and t6.

We can ask a number of questions about the case. First, is it, or something relevantly like it, physically possible? I.e., do the *actual* laws of nature permit it? Second, is it, or something relevantly like it, metaphysically possible? Third, if we further specify the story by stipulating that it involves something that dies and then comes to be alive again later, is the resulting story physically and/or metaphysically possible?

(1) We can start with the first question. Is Restoration physically possible? I doubt that anyone *has in fact* reanimated the remains of bacteria or insects (not to mention humans) that have been rendered non-viable by old age and structural damage. Indeed, the case may be technologically impossible, by present-day Earthly standards. Perhaps the technology that would be required to carry out such a procedure is unlikely ever to be developed by creatures with brains like ours. Moreover, the likelihood that such processes of repair will occur *spontaneously*, without intervention by intentional agents, may for all practical purposes be zero.

Still, it would come as a surprise to learn that *the laws of nature* somehow bar the occurrence of such processes. One would think that, in principle, those processes ought to be physically possible, even if humans will never develop the technology needed to make them happen. Typically, after all, a thing that has been partially disassembled and rendered nonfunctional can be reassembled and made functional again, without violating any laws of nature. I can see no antecedent reason to think that organisms are different from cars in this regard.[48] Organisms are just more intricate and harder for us to manipulate.

Admittedly, this is all speculative. Whether the laws of nature permit the relevant 'reanimation procedures' is an empirical question, and nature is full of surprises. I don't know whether these processes are physically possible. But for all I know – and, I suspect, for all *anyone* knows – they are.

(2) Even if Restoration is *not* physically possible, the second question arises: is it metaphysically possible? Is there a metaphysically possible world in which a story relevantly like Restoration is true? Some may think not, on the grounds that the story violates a law of nature and that these laws are all metaphysically necessary (Bird 2007). Others, however, ought to take the story to be metaphysically possible. It is, after all, consistent, conceivable, and intuitively possible. It involves nothing more exotic than some matter, and an associated object or two, possessing different intrinsic

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[48] Perhaps a typical death involves a complex sequence of chemical reactions that, once under way, are physically impossible to reverse. One might think, however, that under unusual circumstances, certain organisms (especially multi-cellular ones) can die in a way that involves no significant or irreversible *chemical* changes at all. One might think that if a living organism is frozen and becomes cryptobiotic, it can be killed merely by being split into pieces. Once broken apart, the organism is no longer *disposed* to be alive again in the future (even after it thaws), and it is natural to say that it is no longer *viable*; hence there are grounds for saying that it has stopped being cryptobiotic and has died. But since the entire process is carried out at a very low temperature, no major changes need occur at the chemical level. Perhaps the organism breaks apart in such a way as to leave each of its constituent cells intact and still cryptobiotic. In that case, it becomes much harder to argue that the organism's death involved a sequence of chemical reactions that is physically impossible to reverse. If there is anything physically impossible about revitalizing the organism, it would have to be the process of putting its pieces back together in such a way as to restore the organism's disposition to live when thawed. For what it's worth, I find it prima facie unlikely that *no* such process is physically possible.

properties at different times, and standing in the right sorts of causal relations. Even if the laws of nature in the *actual* world rule out the given story (which I doubt), surely the there are possible worlds governed by different laws in which something like that story is true.

(3) So let us turn to the third question. Is it physically and/or metaphysically possible that the given processes occur *and in such a way that they involve something that dies and then becomes alive again later*? Suppose that we further specify the story by adding the following:

> Organism Beta dies at t2 or shortly thereafter and is alive at t6, after the 'repaired matter' that composes it is thawed.

Call the resulting story *Restoration+*. In Restoration+, we have one and the same organism first dying, then having its remains restored (whether or not it is present during that process), then returning to life later. Restoration does not take an explicit stand one way or the other on the question of whether something dies and later returns to life; Restoration+ does. Are there metaphysically possible worlds at which Restoration+, or something relevantly like it, is true?

For those who admit the metaphysical possibility of Restoration itself, I can think of two main reasons for denying the possibility of Restoration+. First, one might think that

> (a) Restoration entails that the organism Beta does not really *die* at t2 (or shortly thereafter), when it ceases to engage in metabolism.

Second, one might think that

> (b) Restoration entails that it is a mere *copy* of Beta, not Beta itself, that is alive and composed of the repaired matter at t6.[49]

I don't find either reason especially compelling.

We can start with (a). According to (a), Restoration is not a case in which an organism lives, dies, and is subsequently revitalized; rather it is a case in which an organism is actively metabolic, then becomes cryptobiotic, and then subsequently becomes actively metabolic again, all without dying or becoming dead in the process.

This strikes me as rather strained. It seems to me that by any ordinary standard, Beta is dead at t3 and has been for some time. I doubt that any biologist who considered the case would say that Beta has merely entered a phase of dormancy or cryptobiosis. It did not cease to engage in the relevant life-functions as the result of any of the standard causes of cryptobiosis – desiccation, freezing, etc. Rather, it ceased to engage in those life-functions as the result of a standard cause of *death* – namely, old age and structural damage. Its trajectory thereafter was common to things that have *died*: it continued to sustain further damage and was decomposing – if it even remained present at all! This is quite unlike the typical trajectory of things in cryptobiosis: they remain approximately static. Moreover, by t3, Beta is no longer *disposed* to live (or metabolize), even in circumstances that are favorable to life for things of its kind. It is no longer *viable*. It manages to metabolize again only with the help of advanced technology. Thus the natural thing to say is that, in the story, Beta is dead at t3 and died at some earlier time, probably t2 or very shortly thereafter.[50] On the assumption that Restoration is possible, therefore, it doesn't entail that Beta *didn't* die at t2 or shortly thereafter.

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[49] Third, one might think that (c) Restoration is not detailed or specific enough for (a) or (b) to be true, but that Restoration does entail the proposition that if Beta dies at t2 then it's not the case that Beta is alive at t6. I will assume that (c) does not require separate discussion. In particular, I will assume that the considerations I mount against (a) combine with the considerations I mount against (b) to yield a case against (c).

[50] It's worth considering how far the friend of (a) would be willing to generalize on the claim. Suppose that most of the apparently dead people whose bodies (or remains) are in the morgue have not yet become hopeless$_{ib}$.

Next consider (b), which says that Restoration entails that Beta is neither alive nor composed of the repaired matter at t6. According to (b), the organism that is composed of the repaired matter at t6 is merely a copy of Beta, not Beta itself. Is this plausible? If one (i) holds that Beta dies at t2, (ii) takes the Termination Thesis to be a necessary truth, and (iii) denies the possibility of intermittent presence, then one will accept (b). But as far as I can tell, the rest of us will want to reject it.

Opponents of the Termination Thesis will presumably want to say that the organism Beta continues to be present throughout the entire story. After all, it's not as if Beta's death is especially violent. Its remains don't get scattered or radically altered in shape or superficial appearance. Throughout the entire case, there is what would ordinarily be described as 'the body of an organism'. Thus, if it *ever* happens that a thing continues to be present for a while after it dies, this would seem to be just such a case. In particular, if one rejects the Termination Thesis, then the overwhelmingly natural thing for one to say will be that, in the story, Beta is alive from t1 to t2, that Beta dies at t2 or shortly thereafter, that Beta continues to be present as a dead thing, that it gets frozen at t3, that it gets repaired from t4 to t5, that it is then thawed and revived, and that it is alive again at t6. This conflicts with (b).

But even those who *accept* the Termination Thesis will presumably want to say that Beta dies and lives again later (or at least that Restoration doesn't rule this out), unless they take a hard line against the metaphysical possibility of intermittent presence.[51] For suppose that Beta dies and ceases to be present at t2. Then if it's so much as *possible* for a material substance to become present again after it has ceased to present, it ought to be possible that Beta does this at some point during the process of repair and revitalization.[52] After all, the 'repaired organism' is made of the same matter, in roughly the same arrangement, as was the original organism (Beta) just before its death, and no *other* organism was composed of that matter in the interim. Moreover, the final pre-death phases in Beta's life presumably stand in a rather intimate causal relation to the initial post-repair phases in the life of the repaired organism: the repaired organism has the intrinsic properties that it has at t6 largely because the original organism had the intrinsic properties that it had just prior to t2.[53] If Beta had been different

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Should we say that they haven't yet died? Suppose that Lenin hasn't yet become hopeless$_{ib}$. Has he not yet died? I think we should say 'No' in both cases. To the extent that I have any grip at all on the dies at relation, I know that it's a relation that Lenin bears to some time in the year 1924. Lenin has died, even if it turns out to be physically possible for him to live again. Similar points are made by Hershenov (2003a) and are discussed by Belshaw (2009: 35-37).

[51] Wiggins (1980) and Lowe (1983) deny the possibility of material objects that undergo intermittent presence. This possibility is embraced by Hershenov (2002) and (2003b), Hoffman and Rosenkrantz (1997: 159), Baker (2005), Merricks (2009), and nearly all friends of temporal parts – e.g., Hudson (2001).

[52] Among friends of intermittent presence, there is controversy about what it takes for a thing to 'jump a temporal gap' in its career. Some say that at a certain causal relation, immanent causation, must hold between the thing's final pre-gap phases and its initial post-gap phases (Zimmerman 1999). Some say that the matter that composes the thing in its final pre-gap phases must be identical with, or mostly overlap, the matter that composes the thing in its initial post-gap phases, and that this matter must be arranged in the same way at both times (Hershenov 2002, 2003b). Some say that if the thing is a person, then some sort of connectedness or continuity must hold between its pre-gap and post-gap psychological states, or that the pre- and post-gap persons must 'have the same first-person perspective' (Baker 2000, 2005). For further discussion, see Merricks (2009), whose defense of intermittent presence is bound up with his claim that there are no true and informative critieria of personal identity over time, and Johnston (2010: 90-125).

[53] Might some *even more intimate* causal relation be required, if the given phases are to be phases in the career of single material substance? (After all, in light of the processes of repair that occur during the gap, some of the particles that compose the repaired organism have the relative positions that they have not purely because of the operations of the organism's own internal life processes, but also because of the processes of repair that were imposed from the outside.) Perhaps. But I take it the momentary condition of complex object is always (in the actual world) partly caused by external forces and events. Moreover, I don't see what's to stop us from simply considering a different case, in which the requisite immanent causal relations do obtain, but which is otherwise

in any of various ways prior to t2, the repaired organism would also have been different in those same ways at t6. Finally, it's plausible that if the given organisms are (or constitute) *people*, then those people could be psychologically continuous with each other and could stand in any other mental relations that might be required to support the intermittent presence of a person. In sum, even Terminators should reject (b), unless they are foes of intermittent presence.[54]

The issues here are complex and subtle, and they allow for a wide variety of internally consistent, stable positions. We shouldn't expect any decisive refutations. On the whole, however, neither (a) nor (b) looks very promising to me. If one admits, as I think one should, the metaphysical possibility of Restoration, then one ought to admit the metaphysical possibility of the more specific story Restoration+, in which Beta dies and later returns to life.

And in that case one ought to reject Irreversibility_2. Even if it is *true* that things die only when they become hopeless_{ib} (which I doubt), this is not *metaphysically necessary*: there are possible worlds in which a thing dies and later comes to be alive again, all in conformity with the laws of nature governing the given world. Hence there are possible worlds in which a thing dies without then becoming such that its intrinsic history, together with the laws governing the given world, guarantee that the thing won't be alive again later. Contrary to Irreversibility_2, becoming hopeless_{ib} is not necessary for dying.

As I said earlier, I suspect that for all anyone knows, Restoration is physically possible. But it's plausible that if Restoration is physically possible, then so is Restoration+. This makes me suspect that for all anyone knows: (i) *Restoration+* is physically possible and hence (ii) there are physically possible counterexamples to Irreversibility_2.

2.5 Irreversibility_3: the *technological* impossibility of living again

Because it invokes the notion of physical impossibility, Irreversibility_2 makes it 'too hard' to die. Contrary to Irreversibility_2, a thing can die at a time even if it continues to be physically possible for the thing to live again.

One likely suggestion at this point is that we should understand irreversibility not in terms of physical impossibility but rather in terms of technological impossibility. Roughly put, the idea is that instead of saying that a thing dies when its having ceased to be alive becomes 'physically' irreversible, we should say that it dies when its having ceased to be alive becomes 'technologically' irreversible. This might lower the bar for dying. Even if it is still physically possible for a given organism to return to life, it might not be technologically possible.

The rough idea can be spelled out in significantly different ways, depending upon which notion in the vicinity of technological possibility is invoked. One way of spelling out the idea is

> Tech_t Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if (i) x ceases to be alive at or before t and (ii) at t, x becomes such that no technology *that is present at t* could be successfully used to make x become alive again.

According to Tech_t, whether or not a given thing x dies at a given instant t can depend upon which technologies exist at *t* (hence the subscript). A different way of spelling out the idea is

> Tech_a Necessary, for any x and any t, if t is an instant, then x dies at t if and only if (i) x ceases to be alive at or before t and (ii) at t, x becomes such that no technology that is 'available' to x at t could be successfully used to make x become alive again.

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as much like Restoration as possible – perhaps a case in which the reversal of damage occurs 'by chance' and involves a relatively minor changes.

[54] Henceforth I will leave this qualification implicit.

According to $Tech_a$, whether or not a given thing x dies at a given instant t can depend upon which technologies are *available* to x at t.

What's supposed to be the difference between $Tech_t$ and $Tech_a$? In particular, what's the difference between a technology's being present at a time and its being available to a certain thing at a certain time? The thought here is that there might be *present* technologies that would, say, allow us to bring Lenin back to life, but these technologies might not be available to Lenin or to any of us at the present time. If these technologies are currently located only in the Andromeda galaxy, or only deep in the Marianas trench where they are employed by a race of super-intelligent squid, then they are not *available* to Lenin or any other human being on Earth at this time. Both principles face serious and rather obvious problems.

The first and most fundamental problem is that they entail that whether a thing dies at a given time can depend upon extrinsic factors that intuitively should have no bearing on the thing's vital status. To see this, consider:

> **Alpha and Omega**. Alpha and Omega are duplicate organisms of the same species that live at different times. At t1, as a result of damage, Alpha ceases to be alive and starts to decay. No technology that is present at t1 could reverse the situation. Hence no such technology is *available* to Alpha at that time. Omega's career is an intrinsic duplicate of Alpha's career (and is governed by the same laws of nature) but occurs later. Thus Omega, as it is when it is n years old, is a duplicate of Alpha, as *it* is when *it* is n years old. At t2, Omega ceases to be alive and starts to decay just as Alpha did. However, at t2, new technology is present and is available to Omega. This technology could be used to revitalize Omega, but is not so used. Omega continues to decay in just the same manner as did Alpha.

$Tech_t$ and $Tech_a$ both entail that Alpha dies at t1 but that Omega does not die at t2. This is extremely implausible. Intuitively, whether or not a given organism o dies at a given instant t should be fixed by facts about the laws of nature governing o, together with facts about what o is like intrinsically at certain times – times such as t itself, any earlier instants at which o is present, and perhaps some fairly brief period of time following t. The point is well put by David Hershenov: "death is best thought of as a nonrelational alteration in an individual's body or organs. 'Death' is a biological concept (and a nonrelational one) and thus should be determined solely by biological factors rather than technological features." (2003a: 93).

Regardless of how one articulates this 'intrinsicality of dying' principle in detail, it will entail that whether or not an organism dies at time cannot depend upon *wildly* extrinsic factors, such as facts about what sorts of technologies are present or available to the organism at the given time. Hence, on any remotely adequate way of formulating the principle, it will say, when applied to the case above, that Alpha and Omega don't differ in whether they die (at t1 and t2 respectively). Thus the intrinsicality principle will rule out $Tech_t$ and $Tech_a$.

Here is a second problem for both versions of $Irreversibility_3$. It seems to me that neither $Tech_t$ nor $Tech_a$ states a *sufficient* condition for a thing to die. Suppose that Gamma has ceased to live by going into cryptobiosis. Further, suppose that, at time t, it becomes technologically impossible for Gamma to live again, not because of any intrinsic change in Gamma, but because the only existing technology that could have been used to revive Gamma ceases to be available to it, and indeed ceases to be present altogether. (Perhaps the civilization that developed the technology is destroyed in a nuclear war.) As applied to such a case, both formulations of $Irreversibility_3$ will tell us, incorrectly, that Gamma dies at t.

Third, it seems to me that neither $Tech_t$ nor $Tech_a$ states a *necessary* condition for a thing to die. In the Restoration case, I claimed, Beta dies at t2. But technology is then available to Beta that could be – and indeed *will* be – successfully used to revive Beta, and such technology continues to be available to Beta throughout the rest of the story. So Beta's ceasing to be alive does not then become ‘technologically irreversible’ in either of the relevant senses. Thus both formulations of Irreversibility_3 tell us, incorrectly, that Beta does not die at t2.

2.6 Incapacitation

In effect, we have so far been asking, ‘What’s the difference between dying and becoming cryptobiotic?’ I think the difference is best captured in terms of dispositions or capacities, roughly as follows. When a living thing becomes cryptobiotic, it retains a sufficiently robust, intrinsically-grounded *disposition* or *capacity* to be alive (under an appropriate range of conditions). In short, it remains viable. But when it dies, it loses the relevant capacity; it ceases to be viable. Neither dead things nor cryptobiotic things are alive. But cryptobiotic things are viable, whereas dead things are not.

This doesn’t entail that it’s physically or technologically impossible for dead things to return to life. What it does entail is that it’s ‘harder’ for dead things to return to life than it is for cryptobiotic ones. Cryptobiotic things often do it ‘on their own’, ‘without external intervention’ and without first being repaired.[55] Dead things need help, or else a lot of luck.

Ingmar Persson has suggested a definition of ‘dies’ that harmonizes with these thoughts. Persson’s definition entails the following instance of schema S:

> Incapacity Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if ‘at t, x loses the capacity to live’ (1995: 501).[56]

In my view, this account has two important virtues. (However Persson himself invokes only one of these, and he seems to deny that the account has the other). Indeed, as far as the problems about cryptobiosis go, the account is approximately right. But I also think that it has a drawback worth noting. I’ll start with the virtues.

Virtues

First, as Persson notes, Incapacity plausibly makes dying an intrinsic matter (or at least a *not-radically-extrinsic* matter). Whether or not a thing x has, at a time t, the capacity to φ depends only on the intrinsic properties that x has at t, together with the laws of nature – at least when the property φ-ing itself is intrinsic.[57] Suppose that two chameleons are intrinsic duplicates and are governed by the same laws of nature. Then, if one of them has the capacity to turn brown, so does the other. If two

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55 Developing certain ideas from Lawrence Becker (1975) and David Cole (1992), Hershenov writes that

> Given all the problems canvassed above, I suggest that whatever account of death one ends up defending, that a provision be included which maintains that human beings are dead when they cannot revive themselves, i.e., the pertinent organs cannot resume their functioning without external intervention (2003a: 99).

If *external interventions* are restricted to *the intentional acts of sentient beings*, then I suspect that in some cases it is physically possible (even if highly unlikely) for a dead thing to return to life without external intervention.

56 Persson takes his proposal to solve the problem about cryptobiosis. He adds a further clause to deal with the problem about fission.

57 The facts about a thing’s dispositions and capacities might not be fixed by its intrinsic properties alone, for two reasons.

First, one might think that there could be intrinsic duplicates in different possible worlds governed by different laws of nature; these duplicates might have different dispositions and capacities. In our world, where it’s a law that opposite charges attract, a given electron e might have the disposition or capacity to attract positively charged things. In a world governed by the law that opposite charges repulse, there might be a duplicate of e, e*, that lacks the disposition or capacity to attract positively charged things.

Second, even within a single world (with unchanging laws), intrinsic duplicates might not always have the same dispositions or capacities. I might lose the capacity to lift Frank without changing intrinsically, if Frank gains weight. I might lose the disposition to cry when struck by Frank without changing intrinsically if Frank becomes weaker. See McKitrick (2003) and Fara (2009).

people are duplicates and one of them is lactose intolerant (lacks the capacity to digest lactose), then so is the other. So, since being alive is intrinsic (or almost intrinsic[58]), we get the result that whether not a given thing has, at t, the *capacity* to be alive will depend only on the thing's intrinsic properties at t, together with the laws. Organisms that are intrinsic duplicates and governed by the same laws will never differ with respect to the capacity to be alive. And two duplicate organisms that undergo duplicate 'internal processes' over a given interval (and are governed by the same laws) will never differ with respect to whether they *lose* the capacity to be alive during that interval.

Thus, unlike $Irreversibility_1$ and $Irreversibility_3$ (but like $Irreversibility_2$), Incapacity avoids the bizarre result that whether or not a thing dies at a time can depend on 'wildly extrinsic' factors. At time t, when distant events make it physically impossible for the frozen, intrinsically unchanging tardigrade ever to live, that organism doesn't lose the *capacity* to live and so, according to Incapacity, doesn't die. The tardigrade does, however, plausibly lose that capacity at t*, when it's damaged by radiation. So Incapacity again yields the desired verdict – namely that the tardigrade *does* die at t*. Incapacity also helps with the case of Alpha and Omega. These organisms have duplicate careers, and they both cease to perform any life-functions and begin to decay at an age of n years old. Since Omega has access to 'revitalization technology' at the relevant age but Alpha does not, $Irreversibility_3$ says that Alpha dies at an age of n years but that Omega does not, despite their intrinsic similarity at those ages. Incapacity does better. In view of their intrinsic similarity and the fact that they are governed by the same laws, either they both lose the capacity to live at age n years, or neither of them does. So, according to Incapacity, either they both die at that age, or neither does. This seems right.

Incapacity also has a second virtue. One can lose the capacity to do something without its then becoming physically impossible for one ever to do it again. Broken watches get fixed, athletes make comebacks, and so on. If one stops exercising for a while, one might lose the capacity to bench press 150 lbs. Then, after lifting weights for a few months, one might regain that capacity. One thus loses the capacity to bench press 150 lbs without then undergoing some internal change that makes it physically impossible for one ever to bench press 150 lbs again. Or some engine component in one's car might break, causing the car to lose the capacity to run, without its then becoming physically impossible for the car to ever run again.

Thus, unlike $Irreversibility_1$ and $Irreversibility_2$ (but like $Irreversibility_3$), Incapacity allows for the possibility of a thing – such as the organism Beta in the Restoration+ case – that dies at a time without its then becoming *physically impossible* for the thing ever to be alive again. In that case, it seems plausible to say that Beta *loses* the capacity to be alive at t2, when it stops metabolizing and starts to decompose, and that it *regains* that capacity later on, at some point during the process of repair. (Still later, it goes on to *manifest* or *exercise* that capacity.) According to Incapacity, therefore, Beta does die at t2, even though it continues to be physically possible for Beta to live again.

Interestingly, Persson himself does not see the matter this way. Instead, he says that his proposal is equivalent to Feldman's (1995: 501). Accordingly, Persson does not argue, as I have, that Feldman's account faces a problem that Incapacity avoids. If I'm right, Incapacity deserves more credit than Persson gives it.

In sum, Incapacity has two major virtues: (i) it doesn't entail that dying is a 'wildly extrinsic' matter, and (ii) it doesn't entail that, as a matter of metaphysical necessity, post-mortem revitalization is physically impossible. Indeed, I'm not aware of *any* plausible counterexamples to Incapacity stemming from cryptobiosis, revitalization, or any similar phenomenon.

Moreover, Incapacity vindicates a rough but appealing analogy – namely, that dying is for organisms more or less what breaking is for cars. A car needn't break when it *stops* running, or even when it stops running *permanently*. (One can turn a car off without breaking it.) And cars *do*

[58] See note 25. Whether a thing is alive at a given instant might depend upon facts about what it's a part of, and on facts about what's going on in an arbitrarily brief interval encompassing the given instant. These are not 'radically extrinsic' facts, so they do not, I assume, introduce any 'radical extrinsicness' into the facts about whether a thing has the capacity to be alive.

sometimes break without then becoming such that it's *physically impossible* for them ever to run again. (Broken cars do sometimes get fixed.) A car breaks when it – perhaps temporarily, perhaps reversibly – loses the *capacity* to run.[59]

Likewise, according to Incapacity, an organism needn't die when it stops being alive, or even when it stops being alive permanently. (It can become cryptobiotic instead, and perhaps suffer damage and die much later but before it ever returns to life.) And it seems at least metaphysically possible for an organism to die without then becoming such that it's physically impossible for it ever to live again. With enough technology, we might be able to revive things that have died, at least if they haven't decayed too much and were not too complex to start with. Instead, a thing dies when it – perhaps temporarily, perhaps reversibly – loses the *capacity* to be alive. Thus Incapacity suggests an analogy between living organisms and running cars, between dead organisms and broken cars, between cryptobiotic organisms and cars that are not running but still work, and between dying and breaking. To the extent that one takes these analogies to be independently plausible, one might take the fact that Incapacity vindicates them as a third point (however weak) in its favor.

A Vice

The word 'capacity' probably introduces some context-sensitivity into 'at t, x loses the capacity to live' that is lacking in 'x dies at t'.[60] This in itself is no problem for Incapacity, provided that the relation expressed (relative to the present context) by the former expression is necessarily coextensive with the relation expressed by 'x dies at t'.

But I wonder how likely it is that those relations are necessarily – or even actually – coextensive. After all, I doubt that there is some uniquely natural or 'reference-eligible' relation in the vicinity that both expressions can just 'lock onto'. Rather, I suspect that there is a huge range of more-or-less equally natural relations in the vicinity that differ just a little from one another. Consider, e.g., the relations expressed (relative to the present context) by:

- 'at t, x loses a robust capacity to live'
- 'at t, x loses a very robust capacity to live'
- 'at t, x ceases to be very capable of living'
- 'at t, x ceases to be disposed to live in normal conditions'
- 'at t, x ceases to be viable'
- 'at t, x ceases to be robustly viable'
- 'at t, x ceases to be even remotely viable'

Some of these relations may have the same extension in the actual world but different extensions in other possible worlds. Others may have different (but probably largely overlapping) extensions even in the actual world.

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[59] There may be counterexamples. But as long as the claim is approximately right, we still have a rough analogy.

[60] A predicate is *context-sensitive* iff its content (the property or relation it expresses) depends upon some feature of context. It seems to me that 'loses the capacity to live' is a better candidate for being context-sensitive than is 'dies'. After all, phrases of the form 'is capable of φ-ing' and 'has the capacity to φ' are plausible candidates for being context-sensitive more generally. If a historian discovers a 200-year-old collection of guns, most of them badly corroded, she might find one that's in especially good condition and say truly, 'This one's capable of firing. It's in perfect condition.' If the same gun, in the same intrinsic condition, is used in a weapons-safety class, the instructor might say truly, 'This one's not capable of firing. It's not cocked.' If 'has the capacity to live' is context-sensitive, it's natural to think that 'loses the capacity to live' is too. I see no similar reason to think that 'dies' is context sensitive.

Manley and Wasserman (2007) suggest that many *disposition* terms such as 'fragile' are context-sensitive, and they point out that this is perfectly consistent with the claim that each of the properties that the predicate expresses (relative to one or another context) is *intrinsic*. I suspect that parallel remarks go for 'is capable of φ-ing', 'has the capacity to φ', and 'loses the capacity to φ'.

None of them seems any more likely than any of the others to be necessarily coextensive with dies at, and each seems to be roughly as good a candidate as the relation expressed by 'at t, x loses the capacity to live'. So I'm not confident that 'x dies at t' and 'at t, x loses the capacity to live' express necessarily (or even actually) coextensive relations.

Accordingly, I'm not confident that Incapacity is true. But there probably isn't much we can do to improve on it. Things die when they cease to have a *sufficiently robust* capacity to live. How robust is sufficiently robust? I see no way to give an informative answer to this question. The best we can do is to point to examples.

After so many false starts, this may seem a bit anti-climactic and underwhelming as a positive view. Admittedly, Incapacity is less informative and less precise than one might have hoped. But as far as the problem of cryptobiosis goes, I doubt we can do better. In my view, all the other accounts we've considered do worse.

Before we turn to a different puzzle about death, one final point about Incapacity: it leaves open the possibility of a thing that dies without ever having been alive. We can imagine an organism popping into existence fully formed but in a state of cryptobiosis. If it shattered and ceased to be viable soon thereafter, Incapacity would yield the result that it died, even though it never lived. This is in the spirit of the 'intrinsicality of dying' principle that we gestured toward earlier. If two cryptobiotic things undergo the same sequence of intrinsic changes over a given interval (and are governed by the same laws of nature), they shouldn't differ with respect to whether they die during that interval, even if only one of them was ever alive previously. Incapacity respects this claim.

3. Fission

To die is not merely to cease to be alive. For one thing, an organism that goes directly from being alive to being cryptobiotic does cease to be alive but doesn't die – at least not then! For another, if an amoeba divides into two new amoebas, it does cease to be alive[61] – indeed, it ceases to be present at all. But, as Jay Rosenberg has pointed out, it doesn't die then.[62] (Or *ever*, unless the case is rather bizarre. See the 'Annie' case at the end of section 4.) The passage from Rosenberg is worth quoting:

> Some amoebae, to be sure, do die. Sometimes an amoeba cannot get sufficient food or oxygen or moisture to sustain its life, and that kills it. But some amoebae do not get an opportunity to die . . . let us consider a well-fed, healthy amoeba alone in a drop of well-oxygenated pond water. I shall call it 'Alvin'. Alvin, let us suppose, lives happily through Tuesday and then, precisely at the stroke of

[61] There are, of course, various ways of resisting the claim that amoebas typically cease to be alive when they divide. One might take the original amoeba to be identical to one of its fission products but not the other, despite the apparent symmetry of the fission. One might embrace 'temporally relativized identity' and say that the original amoeba is identical to each of its fission products, while denying that those products are identical to each other after the fission (Gallois 1998). One might follow David Lewis's treatment of personal fission (1983: 55-76) and claim that, despite appearances, there are actually two amoebas in the vicinity even before the division; it's just that they both have the same spatial location until after the division. One might hold that the situation involves just a single amoeba that is singly located prior to the fission but bi-located thereafter (Dainton 2008). And one might take it that, definitely, the original amoeba is identical to exactly one of its two fission products but that, for any x, if x is one of the original amoeba's fission products, then it is not the case that, definitely, the original amoeba is identical to x (Johansson 2010).

[62] Rosenberg (1983:21-22) makes the point that amoebas do cease to exist but don't die when they divide. Rosenberg's point is endorsed by Feldman (1992: 66), Wierenga (1994), Persson (1995), Kass (1997: 22), Wilson (1999: 101), McMahan (2002: 425), and Luper (2009: 47). Belshaw (2009: 228, note 10) expresses agnosticism but indicates that he leans toward the claim. Hershenov (2006: 113) rejects the claim. Rosenberg doesn't explicitly address the question of whether amoebas *cease to be alive* when they divide. Feldman claims that they do, and he concludes that the case of amoebic fission is a counterexample to the claim (endorsed by Rosenberg) that to die is to cease to be alive.

> midnight, Alvin divides, producing two offspring whom I shall call ‘Amos’ and ‘Ambrose’. On Wednesday, we find two amoebae – Amos and Ambrose – swimming happily about in our drop of pond water. But what has become of Alvin? One thing is quite clear: Alvin is not an inhabitant of our drop of pond water on Wednesday. . . His life, therefore, must have come to an end. But it is equally clear that Alvin did not die (1983: 21-22; 1998: 34-35).

Fred Feldman accepts Rosenberg’s point and draws parallel conclusions about certain cases of biological fusion. His main example involves chlamydomonas, single-celled plants that sometimes engage in a process of fusion in which two haploid individuals combine to form a new, diploid individual. Feldman claims that when a haploid chlamydomona engages in fusion, it ceases to be alive but doesn’t die. (As Feldman notes, one might take certain cases of metamorphosis to have a similar structure. Perhaps caterpillars cease to be alive but don’t die when they metamorphose into butterflies.)

These cases are threats to Incapacity no less than to the Cessation Thesis. Not only did Amos cease to be alive at midnight; he also ceased to have the capacity to live at that time. (I assume that, necessarily, if a thing has, at t, the capacity to live, then it is present at t.) So even if Incapacity solves the problem of cryptobiosis, it’s still false. It offers no help with Rosenberg’s case and its ilk.

3.1 Three Extant Attempts at a Repair

The new puzzle cases all involve biological entities that go directly from being alive to being non-present – and hence not alive – without dying. Why is it that the entities in question do not die in these cases? Presumably there are cases in which a biological entity *does* die when it goes directly from being alive to being non-present. If a healthy, active bacterium is sliced in half and its remains quickly disperse and decompose, maybe it dies and ceases to be present at the same time. Thus a puzzle arises: what’s the difference? Say that a case in which a biological entity goes directly from being alive to being non-present is a *termination*, and that it is *deadly* if the thing dies when it ceases to be present, but *deathless* otherwise. In virtue of what are the deadly terminations deadly? And in virtue of what are the deathless terminations deathless?

Not everyone will be gripped by these questions. Some will lack firm intuitions about the cases. Some will doubt that anything significant is at stake here. I won’t try to argue that the facts about the modal profile of dying have instrumental value. I don’t know what use they are for ethics, biology, or other parts of metaphysics. But for those who find the questions of some intrinsic interest and who would like to press on, there is progress to be made. (Others are free to skip ahead to section 4, which stands on its own.)

First Try: deathless division as division into living things

One thing that all these cases have in *common* is this. We have a living thing and its constituent matter (or some living things and their constituent matter). Then, at a certain instant, the living thing ceases to be present, while the matter continues to be present. Immediately after the thing ceases to be present, the given matter makes up some *other* thing or things. The original thing ‘turns into’ the other things.

So what’s the difference between the deadly and the deathless cases? One natural thought is that the deathless terminations involve a living thing or things that turn into some other *living* thing or things. The reason why an amoeba doesn’t die when it divides is that it turns into two other *living* things; and the reason why two chlamydomonas don’t die when they fuse is that they turn into another living thing. Correspondingly, the reason that the bacterium does die when it gets sliced in half is that none of the pluralities of things that it turns into – *two halves of a bacterium*, or *some organelles and miscellaneous cell-parts*, or *some fundamental particles* – is such that each of its members is alive.

As for the notion of *turning into* invoked here, I doubt that it can be rigorously defined, but here is a rough characterization should be good enough for present purposes:

TI xx *turn into* yy at t if and only if: there is a portion of matter m such that (i) xx are made up of[63] m throughout some interval leading up to t, (ii) each of xx ceases to be present at t, and (iii) throughout some interval that immediately follows t, yy are made up of m, plus or minus a little.

The predicate '___turns into . . . at ****' is non-distributive. From 'a turned into b and c at t', one cannot validly infer 'a turned into b at t' or 'a turned into c at t'. The relation expressed by this predicate has two slots for pluralities of things (corresponding to the two plural variables, 'xx' and 'yy' in TI) and one slot for a time (corresponding to the singular variable 't'). That relation can hold in various patterns: between one thing, many things, and a time (as in the case of amoebic fission), between many things, one thing, and a time (as in fusion), perhaps between one thing, one thing, and a time (in metamorphosis), and between many things, many things, and a time (as when two amoebas divide at the same time, thus turning into four amoebas). The vague phrase 'plus or minus a little' in clause (iii) is needed to allow for cases in which, say, a little matter is lost at the moment of division. Without that phrase, we wouldn't be able to say that the original amoeba turns into the two new amoebas, since the portion of matter that they're made up of at the beginning of their lives *mostly overlaps*, but is not *strictly identical to*, the portion of matter that made up the original amoeba at the end of its life.

With this notion in hand, we can state a new instance of schema S based on the 'natural thought' proposed above. The idea is that a necessary condition for dying is *not turning into some other living thing or things*. Borrowing from Feldman, we can formulate it thus:

A_1 Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if: (i) at t, x loses the capacity to live, (ii) 'it's not the case that x turns into a living thing, or bunch of living things, at t, and [iii] it is not the case that x is a member of a set of living things whose members fuse and turn into a living thing at t' (1992: 68).

Since Rosenberg's dividing amoeba does turn into some living things when it divides, it does not satisfy clause (ii); and as a result A_1 does not tell us that the amoeba dies. Since Feldman's fusing chlamydomonas do turn into a living thing when they fuse, they do not satisfy clause (iii); and as a result A_1 does not tell us that they die. So far, so good.

But as Feldman notes, A_1 is vulnerable to counterexamples too. Suppose that we put a mouse into a 'cell-separator' that 'grinds up mice and emits a puree of mouse cells . . . in such a way that all the mouse cells come out alive' (1992: 69). In this case, Feldman claims, the mouse turns into a bunch of other living things (namely, its cells) and hence it fails to satisfy clause (ii).[64] A_1 thus yields the intuitively incorrect verdict that the mouse does not die when put into the cell separator.

We can extract a lesson. Sometimes, when a living thing turns into some other living things, the original thing dies. Sometimes it doesn't. What's the difference? What makes the mouse's termination deadly? What makes the amoeba's termination deathless?

Second Try: deathless division as division into living organisms

Here is a tempting thought. What makes the amoebic fission deathless is the fact that it involves an amoeba that turns into two amoebas, where both of these resulting amoebas are *organisms* in their

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[63]We can define 'yy are made up of m at t' as '∀x [x overlaps m at t if and only if x overlaps at least one of yy at t]'.

[64] Note that none of the mouse's cells is a *new* entity that comes into existence when the mouse ceases to exist. Rather, each of these cells was present throughout the final moments of the mouse's life. Therefore, the mouse will count as *turning into* its cells in this case only if we understand the notion of 'turning into' in such a way as to allow for the possibility that a thing x, at a time t, turns into the Ys even though none of the Ys is *new*, i.e., even though each of them was present prior to t.

own right; and what makes the mouse fission deadly is the fact that it involves a mouse that turns into mere living cells, where these cells are *not* organisms. The suggestion, then, is this: necessarily, a case of biological fission is deathless if and only if it involves a thing that turns into some living organisms. This suggestion, generalized so as to apply to cases of fusion as well, can be incorporated into a new instance of schema S:

> A_2 Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if: (i) at t, x loses the capacity to live, (ii) 'it is not the case that x turns into a living organism or a bunch of living organisms at t, and [iii] it is not the case that x is a member of a set of living organisms that fuse to form a living organism at t' (Feldman 1992: 70).

But A_2 is vulnerable to the following counterexample, also due to Feldman. An isolated frog cell, C, is kept alive in a laboratory. Eventually, C undergoes fission: it ceases to be present and turns into two daughter cells. Since neither of these is an *organism* (they're both mere living cells), C satisfies clause (ii) of A_2. And since the other clauses are obviously satisfied as well, A_2 yields the verdict that C died when it divided. But this verdict seems wrong. Neither an amoeba nor an isolated frog cell dies when it divides into two new cells. So A_2 is false as well. At this point Feldman draws his discussion to a pessimistic close: 'Fission and fusion are puzzling. I find that I cannot explain the difference between their deathless forms and their deadly forms' (1992: 71).

Third Try: deathless division as division into living things without downgrading
Edward Wierenga is more optimistic. He suggests that the reason why the mouse died when it turned into living cells is that the mouse was an organism but the cells weren't. The mouse, we might say, was 'biologically downgraded'. When the frog cell divided into two frog cells, however, it was not biologically downgraded, since, although the daughter cells were not organisms, neither was the original parent cell. According to this proposal, then, a case of biological fission is deathless if and only if it involves (i) an organism that turns into some organisms or (ii) a living non-organism that turns into some living things (organisms or not). When this idea is generalized in such a way as to apply to fusion as well as fission, it can be grafted on to Incapacity to yield:

> A_3 Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if (i) at t, x loses the capacity to live, (ii) 'if x is an organism then it is not the case that x turns directly into a living organism or a bunch of living organisms at t, and it is not the case that x is a member of a set of living organisms whose members fuse and turn into a living organism at t, and [iii] if x is not an organism then it is not the case that x turns into a living thing, or a bunch of living things, at t, and it is not the case that x is a member of a set of living things whose members fuse and turn into a living thing at t' (Wierenga 1994: 81).

A_3 handles all the cases so far considered. It tells us that the amoeba doesn't die when it divides into two new amoebas; *mutatis mutandis* for the frog cell. And it tells us that the mouse does die when it is sent through the cell separator.

I don't know whether A_3 succeeds, but I suspect not. It depends on what we should say about cases in which a multi-cellular organism is composed of cells each of which is an organism in its own right. If such cases are possible, then there are counterexamples to A_3. For suppose that such a multi-cellular organism is sent through a cell-separator. This strikes me as a way of *killing* that organism and hence that the organism *dies*. But the organism does turn into some living things – its cells – that are themselves organisms, hence it doesn't satisfy clause (ii) of A_3. So A_3 tells us, incorrectly, that the organism does not die.

Could there be a multi-cellular organism each of whose cells is itself an organism? It's easy to image a creature that we'd be tempted to describe that way. But we can focus on an actual case. Consider the slime mold slug (or 'grex'), described here by Jack Wilson:

> At one point in the life cycle of certain species of cellular slime molds, a number of independent, amoebalike single cells aggregate together into a grex. The grex is a cylindrical mass of these cells that behaves much like a slug. It has a front and back, responds as a unit to light, and can move as a cohesive body. The cells that compose a grex are not always genetically identical or even related. They begin their lives as free-living single-cell organisms. The grex has some properties of an individual and behaves very much like one (1999: 8).

Wilson seems to be taking care not to assert that the slug is an *organism* but, for what it's worth, it's easy to find biologists making this assertion in journal articles. ("The cellular slime mold *Dictyostelium discoideum* undergoes a transition from single-celled amoebae to a multicellular organism as a natural part of its life cycle" (Devreotes 1989: 1054). "During the life cycle, solitary amoebae collect to form a multicellular organism" (Siegert and Weijer 1992: 6433).)[65]

So my best guess is that the Wierenga-inspired proposal, A_3, is false. Whether or not a slime-mold slug and its constituent cells are all organisms, I suspect that it's at least metaphysically possible for there to be a multi-cellular organism each of whose cells is an organism too. Such a thing could be sent through a cell separator, and if it were, it would turn into a bunch of organisms, but it would die nonetheless. Or so it seems to me.

3.2 Three New Attempts at a Repair

Three new proposals are worth floating at this point. Call them (i) the *teleological* approach, (ii) the *causal* approach, and (iii) the *generative* approach. Since the problems for Wierenga's proposal are hardly decisive, it's not obvious that the new proposals are even needed. So I'll keep the discussion relatively brisk.

Fourth Try: deathless division as biologically normal division

The teleological approach says – roughly put – that a biological fission is deathless if and only if its occurrence is *biologically normal* and/or has some *biological purpose* or *function*. The thought here is that mice and slime mold slugs die when they go through the cell separator because the divisions in question are not biologically normal. Those divisions do not conform to the normal life-cycle of the entities in question. Amoebas and frog cells divide deathlessly because these divisions are biologically normal. As programmatic as it may be, the idea is already clear enough to generate at least three worries.

First, one might think that facts about biological teleology are grounded in facts about evolutionary history and hence are extrinsic, historical facts. In particular, one might claim that intrinsic duplicates could undergo duplicate processes but differ in whether those processes are biologically normal. Ordinary amoebas evolved; many of their structures and behaviors were selected for. This is why the given behaviors and structures count as biologically normal or have biological purposes. But a 'swamp amoeba' is metaphysically possible. Such a thing is an intrinsic duplicate of an ordinary amoeba, but it has no evolutionary history: it comes into existence via 'cosmic coincidence'. A swamp amoeba might undergo a division that is intrinsically just like the division of an ordinary amoeba. If it did, one might think that its division is just as deathless as the ordinary amoeba's. But since the swamp amoeba has no evolutionary history, many will want to say: (i) that its

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[65] Also see Luper (2009: 47), who mentions slime molds in connection with deathless fission (but not as a counterexample to Wierenga's proposal), and who holds that 'organisms may have component organisms' (2009: 18). For a survey of debates about the concept of an *organism* in philosophy and biology, see Pepper and Herron (2008).

division is not biologically normal and has no biological purpose or function, and hence (ii) that the teleological approach wrongly entails that the swamp amoeba dies when it divides.

A *second* potential objection to the teleological approach concerns actual cases of abnormal cell division. Many cells in multi-cellular organisms undergo *programmed cell death* (apoptosis) as the normal conclusion of their life-cycle. But sometimes, a cell malfunctions and divides into two daughter cells instead of undergoing the programmed cell death that would have been biologically normal for it. In such a case, one might find it plausible that (i) the division is not biologically normal and has no biological purpose or function and that (ii) the cell does not die when it divides (although it does cease to be present and hence does cease to have the capacity to live). If so, then one will see the teleological approach as yielding an incorrect verdict in this case.

The first two objections to the teleological approach argue that a division can be deathless without being biologically normal, and hence that normality is not necessary for deathless fission. A *third* objection argues that normality is not sufficient for deathlessness. Suppose that mice or slime mold slugs had a different evolutionary history. Suppose that they evolved in world in which cell separators were common. Perhaps a certain dramatic end-of-life behavior enhanced the fitness of genetically related individuals and was selected for: the aged organism climbs onto the rim of the churning cell separator, says its final good-byes, and dives straight in. The organism ceases to be present, and a bunch of living cells emerge from the opposite end, preserved in a nutrient bath, waiting to be harvested by the kin of the recently departed organism. (I assume that more realistic examples are not hard to formulate.) In such a case, one might find it plausible that (i) the division is biologically normal and does have a biological purpose or function and that (ii) the multi-cellular organism nevertheless *kills* itself, and hence *dies*, in the process. For what it's worth, this is what I find myself tempted to say about the case. Moreover, such a conclusion shouldn't seem surprising. In cases that don't involve fission or fusion, death is often biologically programmed. In *those* cases, the fact that a given organism or cell is doing something that it is biologically programmed to do doesn't stop it from being true that the organism or cell *dies*. Why should fission cases be any different?

Fifth Try: deathless division as internally-caused division

The causal approach says – roughly put – that a biological division is deathless just in case its proximal causes (or the bulk of them, anyway) are internal to the entity that divides. (A proximal cause is a *direct* cause: c is a proximal cause of e iff c is a cause of e, and there is no c* such that c is a cause of c* and c* is a cause of e.) According to the causal approach, a mouse (or a slime mold slug) dies when it goes through a cell separator because the proximal causes of its division are outside events – namely, the actions of the cell separator machine. The mouse does not divide on its own; some external thing divides it. (This is true even if the mouse is biologically programmed to throw itself into the cell separator.) By contrast, when an amoeba or frog cell divides, it does this on its own. The causes are internal. (Likewise for the malfunctioning cell that divides instead of dying as it was programmed to do.)

It would be nice to be able to say what it is for a given thing or event to be an *internal cause* of a given division, but this is not the place to attempt it. So set this aside, and just *give* the friends of the causal approach the notions they need to formulate their proposal. Even then, the proposal faces at least two problems.

First, one might think that when a planarian is cut in half in a science class and turns into two planarians, the division is deathless but not internally caused. This is a common view among those with whom I've discussed the case, though I find myself without a firm opinion on it.

Second, one might think that, under special circumstances at least, a multi-cellular organism might die when, as a result of internal causes, it divides into its constituent cells. Suppose that I drink a strange poison that becomes incorporated into each of my cells. I feel fine for a few hours. Then, at a certain moment, the poison triggers 'separation behavior' in my cells, so that each cell separates itself from its neighbors while remaining alive. I dissolve into a puree of living human cells. On its face, this is a deadly but internally caused division. The proximal cause of my division is internal, but I die nonetheless.

Sixth Try: deathless division as division into newly living things

The generative approach says – roughly put – that a given division is deathless just in case it involves a living thing that turns into a plurality of living things no member of which was alive before the division.

Thus the mouse (or slime mold slug) dies when it goes through the cell separator because the living things that it turns into – its cells – were all alive before the division. Likewise, I die when I drink the 'separation triggering' poison because the living things that I turn into – my cells – were alive before the division. But the amoeba and frog cell do not die when they divide, because the living things that they turn into – the daughter cells – were presumably not even *present*, much less *alive*, before the division.

In the case of the planarian that gets cut in half, there seem to be three plausible options. First, one can say that (a) when it divides, it turns into two living things – two new planarians – that were not present before the division. Hence, according to the generative approach, the planarian does not die. This seems to be a popular verdict.

Second, one can say that (b) when it divides, it turns into two living things – two planarians – that *were* present before the division but that were not then planarians, or organisms, or even alive. Rather than being living things themselves before the division, they were mere 'arbitrary undetached parts' of a living thing: the right and left halves of the original planarian. So again, the planarian turns into living things that were not alive before the division, and hence the generative approach yields the popular verdict that it does not die.

Third, one can say that (c) when the planarian divides, the two large things that it turns into are not alive. They are mere masses of living cells but are not living things in their own right, at least not yet. Two living things (two new planarians) will eventually develop from those masses of cells, but those new planarians are not present immediately after the division. Thus, when the planarian divides, it turns into *its cells* (each of which is living but not newly living), and it turns into *two cell masses* (neither of which is alive at all), but it does not turn into any plurality of things each of whose members is newly living. In the context of these claims, the generative approach yields the apparently unpopular verdict that the planarian *does* die when it gets cut in half. Is this a problem?

Perhaps some will see this as a problem, but I don't. When I'm in the frame of mind to accept (a) or (b) above, I also find it natural to say that the planarian doesn't die when it gets cut in half; but when I'm in the frame of mind to accept (c), I find it natural to say that the original planarian *does* die when it is cut in half. Thus my intuitions about whether the planarian dies vary as certain metaphysical assumptions about the case vary. But they vary in such a way that they always match the verdict of generative approach. And yet all is not well.

A counterexample. Suppose that we decide to kill a rat by putting it through the cell separator. However, at the very moment that the rat goes through the separator and ceases to be present, each of its constituent cells undergoes fission and turns into two new cells. The result, as before, is a puree of living cells, but this time each of the resulting cells is a *newly created* living thing. This means that the generative approach will say that the rat didn't die when it went through the cell separator. But that's clearly false. The rat does die. The fact that each of its constituent cells just happens to divide at the given moment is entirely irrelevant to whether or not the cell separator kills the rat.

A modification. This problem can be fixed. Granted, the rat turns into some new living things – viz., the daughter cells of the cells that composed the rat in final moments of its life. But, informally speaking, these new living things are not the result of the *rat's* division; rather, they are the result of *its cells'* divisions. Perhaps this explains why our rat dies (despite turning into a bunch of new living things). To capture this suggestion more precisely, it will help to introduce a technical term, 'generative division', defined as follows:

GD x undergoes **generative division** at t =df. there are some yy such that: (i) each of yy begins to be alive at t, (ii) x turns into yy at t, and (ii) there is some y such that:

(a) y is one of yy,
(b) y is not a **fission**-product of something (e.g., a cell) that was a living proper part[66] of x throughout the final moments of x's life,[67]
(c) y is not a **fusion**-product of some things (e.g., some cells) that were living proper parts of x throughout the final moments of x's life[68], and
(d) y is not a **metamorphosis**-product of something (e.g., a cell) that was a living proper part of x throughout the final moments of x's life.[69]

The modified version of the generative approach, then, says this: if a living thing turns into two or more living things at a time t, then it *dies* at t if and only if it does not undergo *generative division* at t. Generative divisions are deathless; the others are deadly.

This proposal yields the intuitively correct verdicts on all of the fission cases we've considered so far: it entails that the amoeba and the frog cell do not die when they divide, and it entails that the mouse, the rat, and the drinker of 'separation-triggering' poison do die when they divide.

With this in mind, we can return to our overarching question, 'When do things die?' If we extend the 'generative approach' in such a way that it applies to fusion and metamorphosis, we can graft it on to Incapacity. The result is a new instance of schema S:

Terminus Necessarily, for any x and any t, if t is an instant, then x dies at t if and only if

(i) at t, x loses the capacity to live,
(ii) x does not undergo generative division at t,
(iii) x does not undergo generative fusion or generative metamorphosis at t.[70]

Terminus says that things die when they lose the capacity to live, provided that they don't simultaneously undergo certain specified forms of fission, fusion, or metamorphosis. Is Terminus a success? I doubt it. But I think it's slightly more likely to be true, or approximately true, than anything else on the table.

Before we leave the topic of fission, I want to point out a potential counterexample to Terminus. Suppose that, for whatever reason, the cells in a slime mold slug start to crawl away from one another and eventually all go their separate ways. By the end of the process, the slug itself is no longer present. Thus the slug ceases to be present, loses the capacity to live, and 'turns into' its constituent cells, which remain alive. Such a division would not count as a *generative* division; no

[66] Typically, 'proper part' is defined as follows: x is a proper part of y at t =df. x is a part of y at t and x≠y. In the present context, however, it will be convenient to define it as follows: x is a proper part of y at t =df. x is a part of y at t, and there is a z such that z is a part of y at t, and nothing is a part of both x and z at at t. The idea here is that a proper part of a thing must 'leave out' some part of the thing.

[67] I.e., it is not the case that there is some z, interval I, and some zz such that: (i) I leads up to t, (ii) z is a proper part of x at each instant in I, (iii) z is alive at each instant in I, (iv) z turns into zz at t, (v) each of zz begins to be alive at t, and (vi) y is one of the zz.

[68] I.e., it is not the case that there is an interval I and things, zz, such that: (i) I leads up to t, (ii) each of zz is a proper part of x at each instant in I, (iii) each of zz is alive at each instant in I, and (iv) zz turn into y at t.

[69] I.e., it is not the case that there is some z and interval I such that: (i) I leads up to t, (ii) z is a proper part of x at each instant in I, (iii) z is alive at each instant in I, and (iv) z turns into y at t.

[70] Define 'x undergoes generative fusion or metamorphosis at t' as 'there are xx and a y such that: (a) x is one of xx, (b) for some interval leading up to t, each of xx is alive at each instant in that interval, (c) y begins to be alive at t, (d) xx turn into y at t'. Unfortunately, this definition is not precisely parallel to the definition of 'generative division', and in fact I don't know *how* to construct a parallel definition. Fortunately, there don't seem to be any counterexamples to Terminus involving fusion or metamorphosis.

newly living things result from it. So Terminus yields the verdict that the slug dies. Some might find this implausible: would a slime mold slug really *die* if its cells merely crawled apart from each other and resumed their independent way of life?

For my part, I lack strong intuitions about the case. I'm inclined to look to Terminus for guidance here and defer to its verdict. Those with stronger intuitions may end up rejecting Terminus on the basis of this case.[71]

4. When are things dead?

Enough about dying. Let's turn to being dead. A final task before we conclude is to formulate a true and informative instance of the following schema:

> S* Necessarily, for any x and any t, if t is an instant, then x is dead at t if and only if ______________.

In this vein, Rosenberg writes:

> 'Aunt Ethel is dead' . . . seems to say just what 'Aunt Ethel has died' says . . . To say that a person is dead, then, seems . . . to report on a past event rather than a present condition. 'Being dead,' as we customarily speak, picks out only the 'nominal condition' of having died (1998: 42-43)

This passage suggests:

> $Dead_R$ Necessarily, for any x and any t, if t is an instant, then x is dead at t if and only if there is some instant t* such that: (i) t* is earlier than t and (ii) x dies at t*.

According to $Dead_R$, a thing is dead at a time just in case it died at an earlier time. As Feldman has noted, anyone who accepts the metaphysical possibility of revitalization cases (e.g., Restoration+) will face pressure to reject Rosenberg's proposal.

Suppose, e.g., that Beta dies at t2 and is alive later, at t6. Then $Dead_R$ counts Beta as being dead at t6. But since Beta is alive at t6 and since being alive and being dead are incompatible with each other, this verdict seems incorrect. If a thing were to die and later be revitalized, it would become dead when it died, but – contrary to Rosenberg – it wouldn't continue to be dead forever after. By the time it returns to life, it will have stopped being dead.

Thus being dead is not a purely historical property. Whether a thing has that property at a given time is partly a matter of the thing's history (the thing must have died, or perhaps die just then) but it is also partly a matter of the thing's present intrinsic condition. If the thing is currently alive, it is not dead, regardless of what happened to it in the past.

To handle these observations, Feldman (1992: 108) offers a definition of 'dead' that entails the following principle:

> $Dead_F$ Necessarily, for any x and any t, if t is an instant, then x is dead at t if and only if there is some instant t* such that: (i) t* is earlier than t, (ii) x dies at t*, and (iii) x is not alive at t or at any instant between t* and t.

Informally, $Dead_F$ says that to be dead at a time is to have died at some earlier time and not to have returned to life since then. This solves the problem about revitalization. Since Beta is alive at t6, clause (iii) is not satisfied, and so $Dead_F$ says, correctly, that Beta is not dead at that time.

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[71] Indeed, some will lack strong intuitions about any of the odd cases considered in this chapter and will be willing to defer to the Cessation Thesis on all of them.

$Dead_F$ does face a different problem, however (Gilmore 2007). Return to the Restoration+ case. At t5, after the repair work is complete but while Beta is still frozen, Beta is an intrinsic duplicate of Gamma, a frozen organism that entered cryptobiosis in the normal way. As I noted, this makes it plausible to say that Beta, like Gamma, is cryptobiotic at t5. But if Feldman, Clegg, and their allies are right, this should lead us to say that Beta is neither alive nor dead at t5. Thus Beta's history is as follows: it is alive at t1, it dies at t2, it is dead for a period of time thereafter, it gets frozen (while dead) and then gets repaired, and by t5 it has become cryptobiotic and has ceased to be dead, though without yet returning to life.

$Dead_F$ yields the wrong verdict here. Since Beta died at t2 and is not alive at t5 or at any instant between t2 and t5, $Dead_F$ tells us that Beta is dead at t5. But – given plausible views about cryptobiosis – Beta is cryptiobiotic and hence *not* dead at t5. Contrary to $Dead_F$, having died and having not returned to life since then is not a sufficient condition for being dead. That proposed condition is compatible with being cryptobiotic, which is incompatible with being dead.

In light of our discussion of cryptobiosis in section 2, the natural fix is to say that a thing is now dead just in case it died (hence lost the capacity to live) at some earlier time (or perhaps just now) and has not regained that capacity since it died. Although Beta has not returned to life as of t5, it has regained the capacity to live by then, and for that reason it is no longer dead. Put more formally, the suggestion is this:

> $Dead_G$ Necessarily, for any x and any t, if t is an instant, then x is dead at t if and only if there is an instant t* such that: (i) either t*=t or t* is earlier than t, (ii) x dies at t*, (iii) it's not the case that: *at t*, x has the capacity to live, and (iv) for each instant t_b between t* and t, it's not the case that: *at t_b*, x has the capacity to live.[72]

Four comments about $Dead_G$ are in order.[73]

(1) Unlike Rosenberg's proposal, but like Feldman's, $Dead_G$ allows for the possibility of 'undead' things, things that are not dead but once were. The dead and the undead are alike in that they've all died. The difference between them, according to $Dead_G$, is that a dead thing lacks the capacity to live and has lacked it ever since some moment at which it died. Not so for an undead thing.

(2) Unlike either Rosenberg's proposal or Feldman's, $Dead_G$ allows for the possibility of things that go directly from being dead to being neither alive nor dead. This was what happened to the organism Beta (in the Resoration+ case) sometime between t2 and t5. At t2, Beta lost the capacity to live and hence died and became dead. It remained dead for some time. Then, at some point during the process of repair, and before it actually returned to life, it regained the capacity to live and hence ceased to be dead.

(3) Unlike either Rosenberg's proposal or Feldman's, $Dead_G$ allows for the possibility of: (a) a thing that is *alive* at the instant at which it dies, (b) a thing that is *dead* at the instant at which it dies, and (c) a thing that is *neither alive nor dead* at the instant at which it dies.

Start with (a). Suppose that Mary is alive at t1, at the later instant t2, and at every instant in between, but at no other instants. Further, suppose that she has the capacity to live at each of these instants, but not at any others. Thus, not only does she cease to be alive at t2, she also loses the *capacity* to live at that time. Finally, suppose that Mary doesn't undergo fission, fusion, or metamorphosis at t2; rather, she stops living as the result of illness. Then – given Terminus – she dies at t2, an instant at which she is still alive. Moreover, given that Mary has the capacity to live at t2, $Dead_G$ tells us that she is not dead then, though she is dead at each instant thereafter.

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[72] I will ignore time-travel-based counterexamples to $Dead_G$. See note 28.

[73] $Dead_G$ is similar in some ways to the definition of 'dead at' – labeled *D3* – proposed in my (2007); these four comments apply, *mutatis mutandis*, to both. But $Dead_G$ does not purport to be a definition or analysis of any word or concept. And $Dead_G$ bypasses the notion of a 'toxic2 property' that gets defined and employed in D3. As far as I can tell, $Dead_G$ avoids the objection to D3 raised by Seahwa Kim (forthcoming).

Next consider (b). Let John's case be just like Mary's, with the exception that John is not alive at t2, nor does he have the capacity to live then. But he is alive, and does have the capacity to live, at t1 and at each instant between t1 and t2. Here again we should say that John loses the capacity to live at t2, and hence – given Terminus – that he dies then. And given that he does not have the capacity to live at t2, $Dead_G$ yields the result that he is dead then, as well as at each instant thereafter.

Finally consider (c), and let Margaret's case be just like John's, with the exception that Margaret is cryptobiotic at t2: she is not alive then, but she does then have the capacity to live. Like John and Mary, Margaret is alive, and has the capacity to live, at t1 and at each instant between t1 and t2. As in the previous cases, we should say that Margaret loses the capacity to live at t2 and hence that she dies then. Given that she does have the capacity to live at t2, however, $Dead_G$ yields the verdict that she is not dead then. Thus Mary is neither alive nor dead at t2, when she dies. According to $Dead_G$, therefore, whether a thing is alive, dead, or neither at an instant at which it dies depends upon the thing's intrinsic condition at that instant. This strikes me as a virtue.

(4) $Dead_G$ is compatible with both answers to the question, 'Do amoebas die when they divide?' Suppose that Amos divided at t1, at which point he ceased permanently to be present and ceased permanently to have the capacity to live. Is Amos dead now, at the later time t2? According to $Dead_G$, that depends on whether Amos died at t1. If he did, then he's dead now (since he does not now have the capacity to live, and has lacked that capacity since some moment when he died, namely t1). If he didn't die then, he's neither alive nor dead now, but merely non-present, like Pangaea and the Colossus of Rhodes.

It's worth noting that $Dead_G$ yields plausible results when applied to more complicated fission cases as well. Let Annie be an amoeba that lives, dies at t1 (of oxygen deprivation, say), is dead for a period of time thereafter, gets repaired and regains the capacity to live, returns to life at t2, and finally divides into two new amoebas at t3. Annie is not present (and hence is not alive and does not have the capacity to be alive) at any time thereafter. Is Annie dead now, at t4? Again this will depend on whether amoebas die when they divide, as it should.

If Annie did die at t3, when she divided, then $Dead_G$ yields the result that she is dead now. For she doesn't have the capacity to live, and this has been true ever since some moment at which she died, namely t3.

But suppose that Rosenberg is right, and Annie did *not* die when she divided. Then $Dead_G$ will tell us that Annie is *not* dead now. Although she doesn't now have the capacity to live, and although she did die at some earlier time (namely, t1), it's *not* true that *she has lacked the capacity to live ever since some instant at which she died*. The only instant at which she died, given Rosenberg's view about fission, is t1. And we *can't* say that Annie has lacked the capacity to live ever since t1. After all, she regained that capacity between t1 and t2 and indeed was *alive* from t2 to t3.

This complicated fission case gives us a reason to prefer $Dead_G$ to certain other tempting repairs to $Dead_F$. Consider, for example,

$Dead_{G*}$ Necessarily, for any x and any t, if t is an instant, then x is dead at t if and only if there is some instant t* such that: (i) t*=t or t* is earlier than t, (ii) x dies at t*, and (iii) x does not have the capacity to live at t.

This handles standard revitalization cases (unlike $Dead_R$) and it handles case in which a thing goes directly from being dead to being neither dead nor alive (unlike $Dead_F$), but given Rosenberg's view about fission, $Dead_{G*}$ doesn't handle the complicated case involving Annie. In that case, $Dead_{G*}$ tells us that Annie is dead at t4. But given Rosenberg's view, what we *should* say, and what $Dead_G$ *does* say, is that Annie is neither alive nor dead at t4.

So it seems that regardless of whether one accepts Rosenberg's view about fission, one will see $Dead_G$ as delivering the right conclusions about all of the relevant cases.

5. Conclusion

When is a thing dead? $Dead_G$ gives an answer in terms of dying and having the capacity to live: roughly, being dead is a matter of having died and having not regained the capacity to live since then. And when does a thing die? Terminus gives an answer in terms of being alive and having the capacity to live. A thing dies, it says, when the thing loses the capacity to live – perhaps temporarily, perhaps reversibly – without undergoing 'generative' fission, fusion, or metamorphosis.

Under what conditions is a thing *alive*? Under what conditions does a thing have the *capacity* to do something or to be a certain way? We would know more about when things die if we had answers to these questions. But Terminus and $Dead_G$ cannot be faulted for remaining mostly silent on them, any more than an account of knowledge in terms of belief, truth, etc., can be faulted for failing to provide a theory of truth. Terminus and $Dead_G$ don't answer every question one might have about death, but this doesn't make them uninformative. They make non-obvious claims about how dying and being dead are related to other notions in the vicinity, and in my view, they constitute a significant improvement upon existing proposals.

Neither of these principles puts itself forward as an analysis or definition of any word or concept. $Dead_G$ gives an account of being dead in terms of dying (inter alia), and Terminus gives an account of dying in terms of being alive. But one can accept these principles without thinking that the concept (or property or relation) of dying is somehow prior to or more basic than the concept of being dead; one might even think that it's the other way around, e.g., that dying is to be analyzed as becoming dead. Terminus and $Dead_G$ take no stand on this. But they do impose *constraints* on attempts to analyze the relevant concepts and to define the relevant words. For example, on the assumption that a thing can cease to be alive without losing the capacity to live, those who accept Terminus should deny that dying can be analyzed as ceasing to be alive.

In this chapter I have sidestepped what some may take to be the really interesting philosophical dispute about death: viz., the dispute between 'brain death' accounts and 'cardio-pulmonary' accounts of human death.[74] One reason for this, as I've mentioned, is that I have tried to give an account of death (or, strictly, *dying*) in general, and most things that die don't have hearts, lungs, or brains.

But there is also a second reason. It seems to me that a human person or human organism, like anything else, dies at an instant t if and only if it loses the capacity to live at t (and doesn't undergo the specified sort of fission, etc.). If this fails to settle the dispute between the brain death account and the cardio-pulmonary account, that's only because each side can still argue that it gives the correct answer to the question 'When does a human person lose the capacity to live?' Perhaps the brain-death theorist can argue that a human person loses the capacity to live at the moment of 'brain death' and the cardio-pulmonary theorist can argue that a human person loses the capacity to live when it loses the capacity for 'cardio-pulmonary function'. If so, then this a dispute worth having, but it is not in the first instance a dispute about death, any more than the dispute between, say, deflationists and correspondence theorists about truth is a dispute about knowledge.[75]

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[74] These two types of account are not exhaustive. See Belshaw (2009: 39-63) for an insightful overview that harmonizes with much of this chapter.

[75] I am grateful to Jens Johansson, Seahwa Kim, and Adam Sennet for helpful comments on this chapter.

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