Cars and Kinesin

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Rule-to-build-by:

To obtain the most successful structure and function of a machine, it is necessary to continually fiddle with aspects of the building design (Morris and Staudinger, 2010).

What:

Motor proteins have evolved through mutation and selection to transport molecules inside the cell efficiently using an ATP as an energy source (Alberts et al, 2009). Cars have evolved through change in design to transport people from place to place safely and efficiently using gasoline as an energy source.

How:

Motor proteins uphold the principle of obtaining optimal structure and function through continuous tinkering of design through the specific and various functions of different proteins. Kinesin proteins and their associated proteins are found in animal cells, and transport organelles such as mitochondria, vesicles and golgi bodies along microtubules ("Motor Protein"). The generic kinesin protein consists of a motor domain which includes the two heads that 'walk' along the microtubules and the ATP binding site which converts chemical energy into kinetic energy, as well as a tail which is the site of binding to a given ligand (Lodish et al, 2000). Each kinesin has a very exclusive ligand, destination, direction and speed. Each of these particular motor proteins are coded for by DNA sequences that are then transcribed into RNA and translated into proteins (Alberts et al, 2009). There are multiple kinesin proteins, each with a singluar specific function and its own gene. The proteins that are produced by the different kinesin genes are called kinesin superfamily proteins also known as KIF's (Miki et al, 2001).

The kinesin motor proteins all have very similar motor domains and almost identical ATP binding sites. There are, however, at least 38 different tails, each carries a different type of cargo. Each kinesin has its own gene that varies slightly from all of the others which gives it its own specialty. There are kinesins that have similar tails, but specific binding proteins that associate with the kinesin allow the binding of certain molecules within the cell (Miki et al, 2001). The regions of DNA that code for the motor domain (heads) and the ATP binding site are highly conserved over evolutionary history. The differences in function of the tails are caused by differences in the regions of DNA that code for the tails. These regions are not very similar from one kinesin to another. There are roughly 100 genes that code for different kinesins and their associated binding proteins.

Families of genes are usually formed in a similar manner across all of biology. One functioning gene during replication is randomly copied an extra time and inserted into the genome. This extra copy of the gene usually gets mutated over time and gains another function (Alberts et al, 2009). Because the kinesin family has over 38 different proteins and 100 genes that contribute to the proper functioning of those proteins, it is assumed that the process of gene

duplication, mutation and selection has occurred many times throughout evolutionary history.

There are multiple types of mutation that can act on the duplicated genes to produce different tail sequences, which in turn produce different functions of similar proteins. Some of these mutations include substitutions or point mutations, insertions, deletions and frame shift mutations. Point mutations change only one nucleotide, which can result in no change of amino acid or a change in amino acid including an early stop codon. Insertions and deletions add or subtract nucleotides into the sequences, which, unless added or subtracted in groups of three, cause frameshift mutations ("Types of mutation"). Frameshift mutations occur when the codons are interrupted by the addition or subtraction of nucleotides, causing the codons from the point of mutation on to be incorrect (Alberts et al, 2009).

Cars uphold the principle of tinkering for optimal function through the constant redesign and improvements to performance, safety and efficiency. There used to be only a few different kinds of cars, and we now have hundreds, each with different features. The basic structure and functions of the cars today are very similar to those that we first started with. We have, however, played with the design of our cars to improve the safety, efficiency, and specificity. Through constant changing of the blueprint, we now have many more and much better cars than we did in the past.

Why:

Motor proteins such as kinesins uphold the rule of constant fiddling of design being necessary for optimal functioning because it is beneficial for an organism to do so. Each time a mutation occurs it is beneficial, neutral or detrimental to the functioning of the motor proteins (Wickstead et al, 2010). Beneficial and neutral mutations will remain in the population, and mutations that inhibit proper or better functioning of the motor proteins will be selected against, and will generally die out of the population. Selection is the driving force behind evolution, and selection for and against gene duplication and mutation of motor proteins such as kinesin allow improvements in the functions of the cell (Miki et al, 2001).

The kinesin family now has over 38 different proteins in humans, each with a specific function. Cells and cellular interactions are more complex then they have ever been in the past, which speaks to the evolutionary advantage of having more motors proteins. More numerous specific motor proteins allow for the selective transport of certain molecules to particular parts of the cell. One example of this is that the human brain, the most complex part of the human body, has the most different types of kinesin proteins than anywhere else in the body (Miki et al, 2001). Research has also found that more complex life forms, such as mammals, have more motor proteins in their cells than less complex life forms. This proves that additional transport within the cell is associated with more complex functions of the cells, which leads to more complex life (Bermudes, 1994).

Cars uphold the rule of tinkering with building plans provides the most optimal design because of the versatility of cars today. In the past cars were only used for transporting people from one place to another. Today cars are used to transport large amounts of people, to tow things, and other various functions. Cars have developed these abilities through constant design modifications and improvements in efficiency, safety, and performance.

Figures:

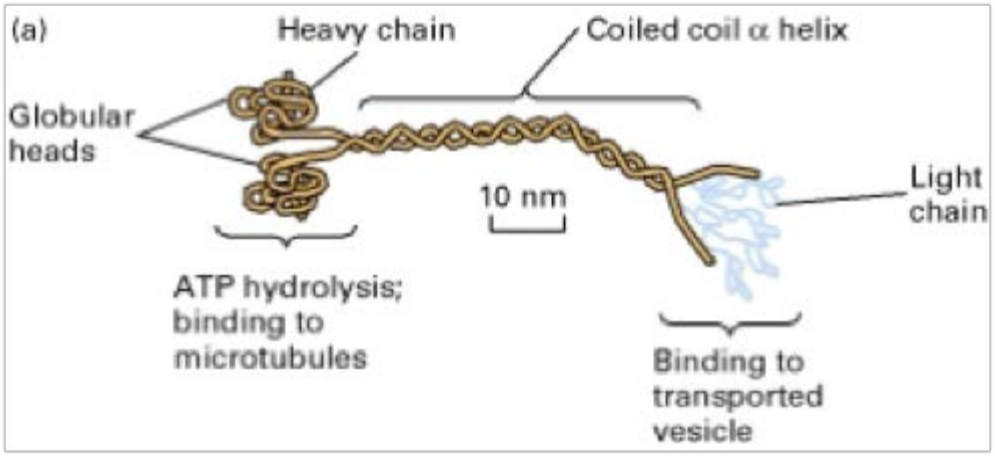

Figure 1. The structure of kinesin proteins allow for transportation of many different molecules within a cell to be efficient, yet highly specific for many different ligands (Lodish et al, 2000).

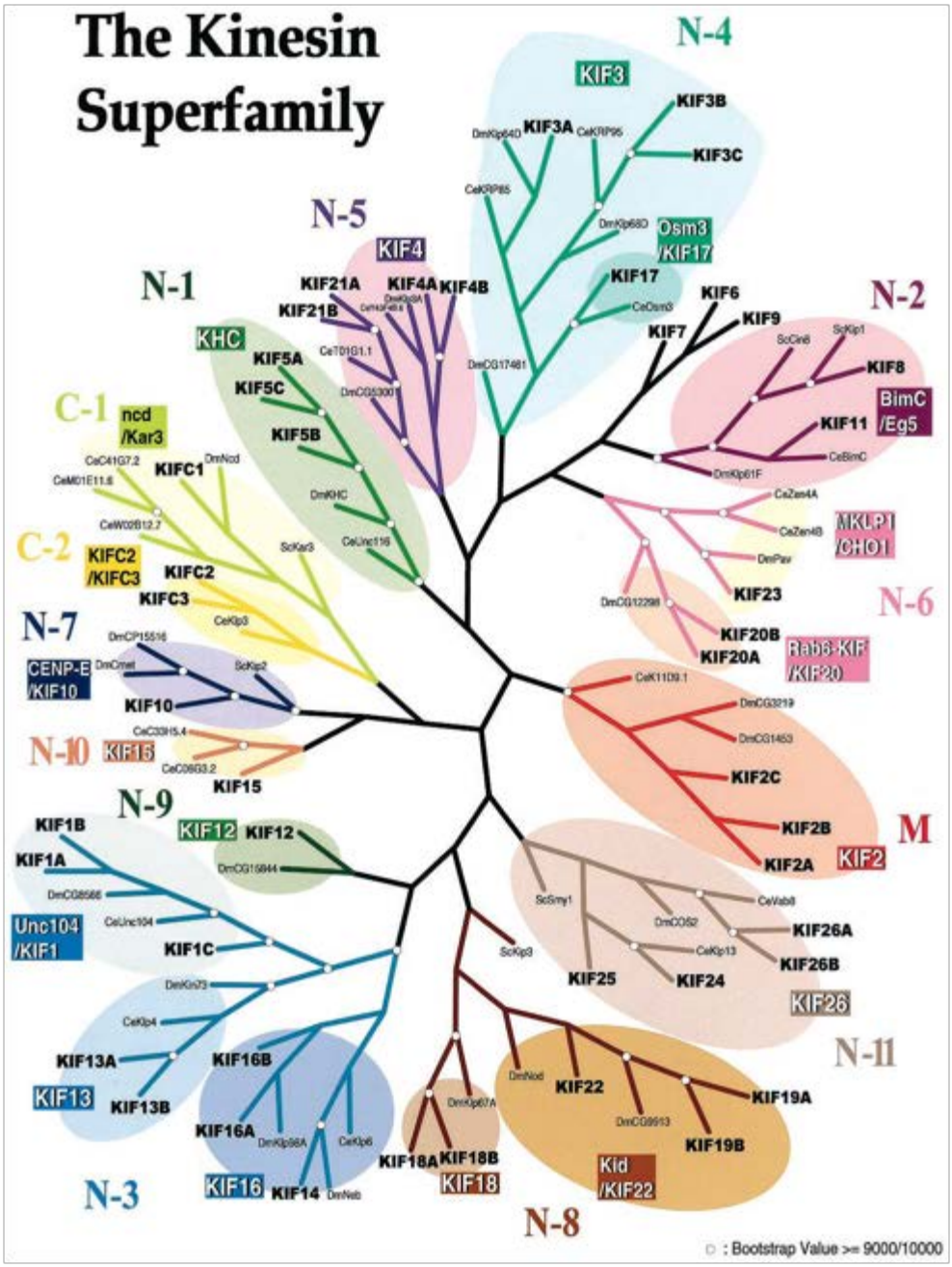

Figure 2. The phylogenetic tree of the kinesin superfamily and subfamilies shows the similarities and differences among each particular kinesin protein, proving the advantage to having more functioning proteins (Miki et al, 2001). Note the various branches of kinesin subfamilies.

Figure 3. An old Ford model T car provides the necessary functions to get a person from one place to another. There are limited amenities in this car, and it is not efficient according to today's standards (Gander, 2010).

Figure 4. A 2012 Volvo not only gets multiple people from one place to another, it can tow large objects, and drive well in the snow. This car is very fuel efficient, safe and performance oriented (Edmunds.com).

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