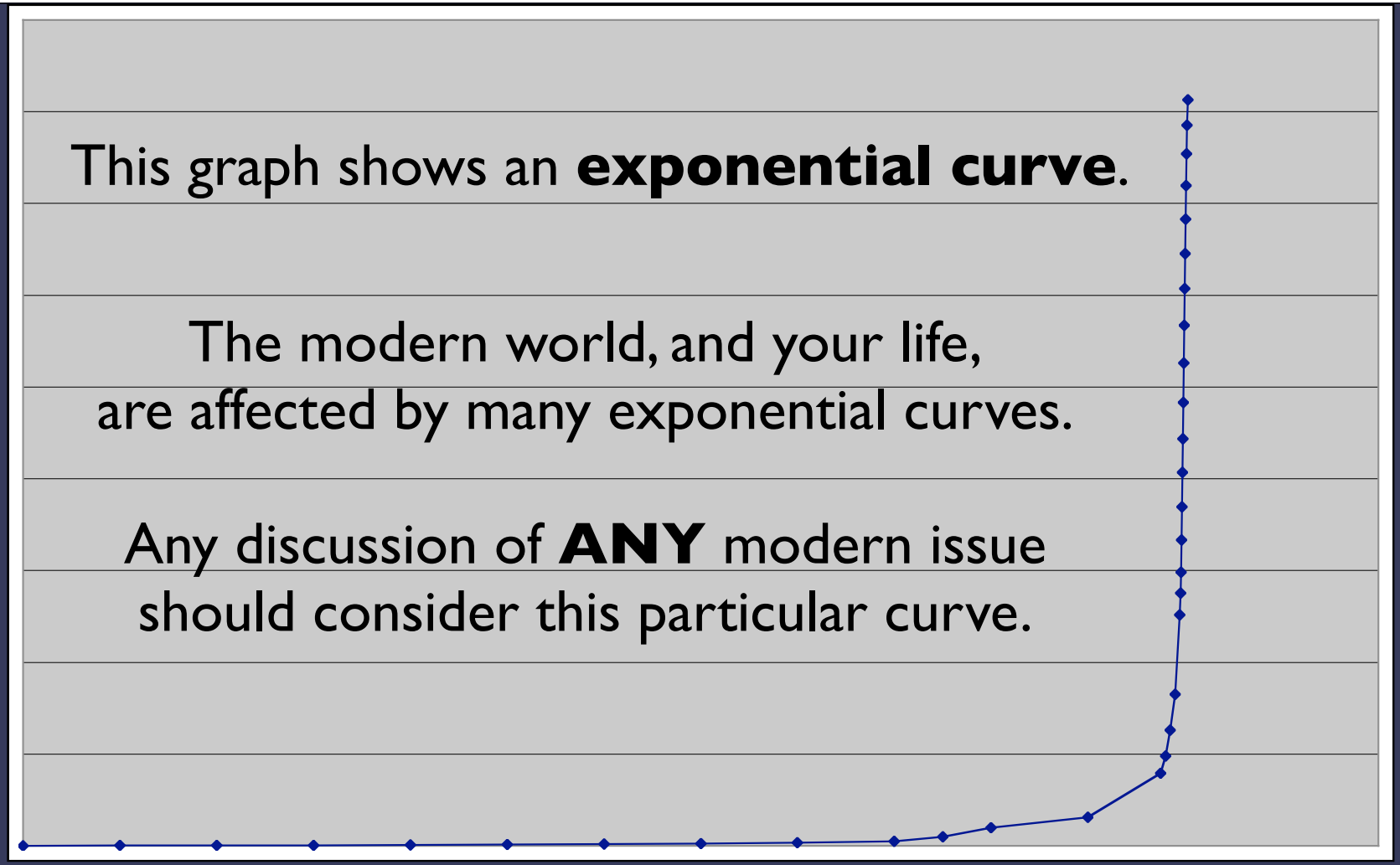
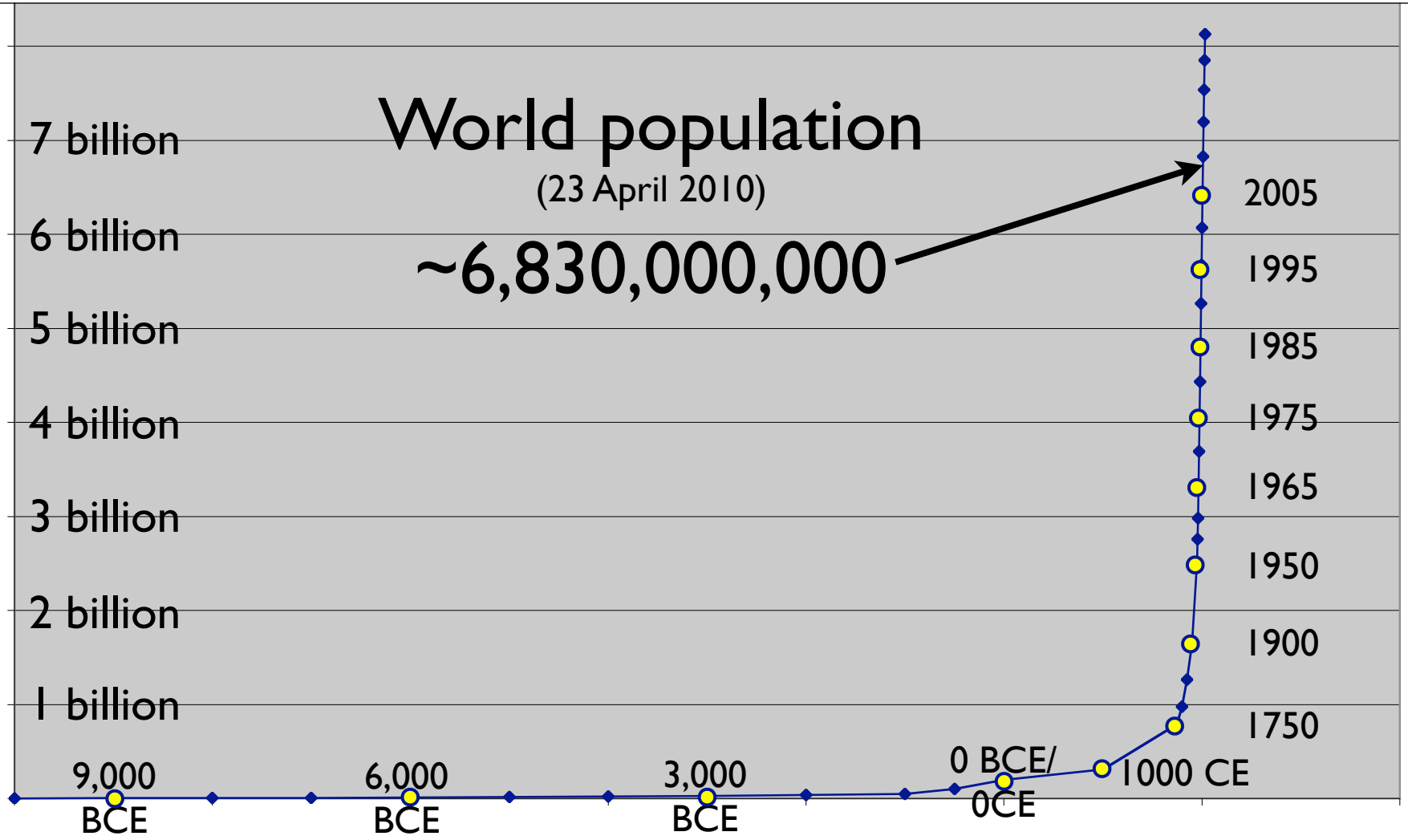


"The most powerful force in the universe is compound interest."

Albert Einstein

"The greatest shortcoming of the human race is our inability to understand the exponential function."

Dr. Albert Bartlett



The simplest model of exponential growth (or decay), known as the Malthusian growth model, can be stated in these equivalent ways:

1. The larger the quantity gets, the faster it grows.
2. The rate of growth is directly proportional to the present size.

The simple formula for time-dependent exponential growth or decay*:

$$x(t) = a * b^{t/\tau}$$ where

a is the initial value of x (i.e., x(0) = a),
b is a growth factor or multiplier (constant > 0)
t is the time period being analyzed,
τ is the time needed for x to increase by b.

*x grows if τ > 0 and b > 1. x decays if either [τ < 0 and b > 1] or [τ > 0 and 0 < b < 1].

Example: A type of bacteria doubles every ten minutes. If we start with a single bacterium, how many bacteria would be present after 1 hour?

a = ? b = ? t = ? τ = ?

a = 1 b = 2 t = 60 min τ = 10 min

$x(t) = a * b^{t/\tau}$ $x(60) = 1 * 2^{60\text{ min}/10\text{ min}}$ $= 1 * 2^6$ $= 64$

Miranda and the Rookie

Sheets | Charts | SmartArt Graphics | WordArt

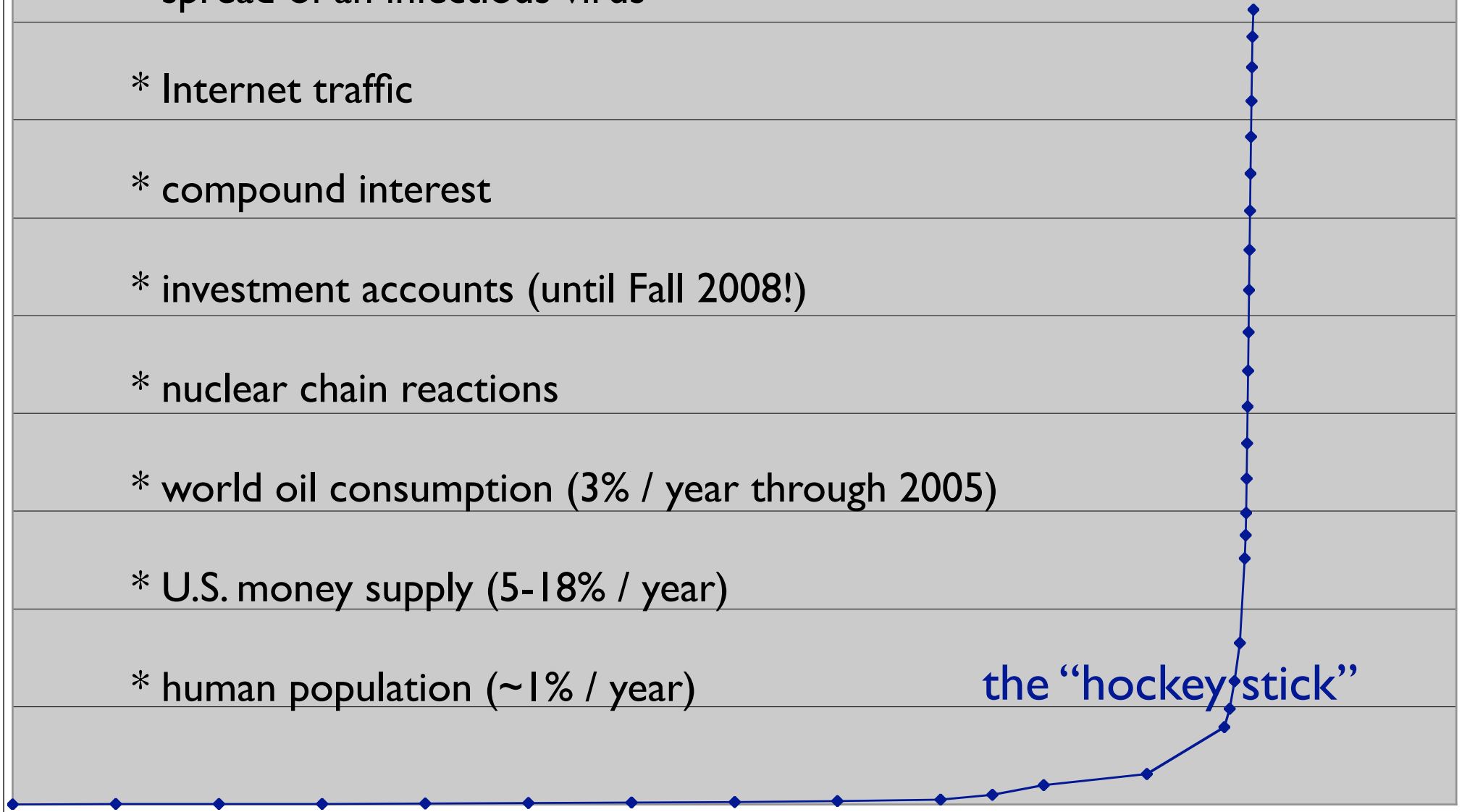
	A	B	C	D	E
1	**Year**	**Miranda's salary**	**Rookie's salary**	**Miranda Total**	**Rookie Total**
2	1	1000000	1		
3	2	1000000	2		
4	3	1000000	4		
5	4	1000000	8		
6	5	1000000	16		
7	6	1000000	32		
8	7	1000000	64		
9	8	1000000	128		
10	9	1000000	256		
11	10	1000000	512		
12	11	1000000	1024		
13	12	1000000	2048		
14	13	1000000	4096		
15	14	1000000	8192		
16	15	1000000	16384		
17	16	1000000	32768		
18	17	1000000	65536		
19	18	1000000	131072		
20	19	1000000	262144		
21	20	1000000	524288		
22	21	1000000	1048576		
23	22	1000000	2097152		
24	23	1000000	4194304		
25	24	1000000	8388608		
26	25	1000000	16777216		
27	26	1000000	33554432		
28	27	1000000	67108864		
29	28	1000000	134217728		
30	29	1000000	268435456		
31	30	1000000	536870912		
32					
33		30000000	1073741823		
35					

The King's Chessboard (≈ The Job Offer)

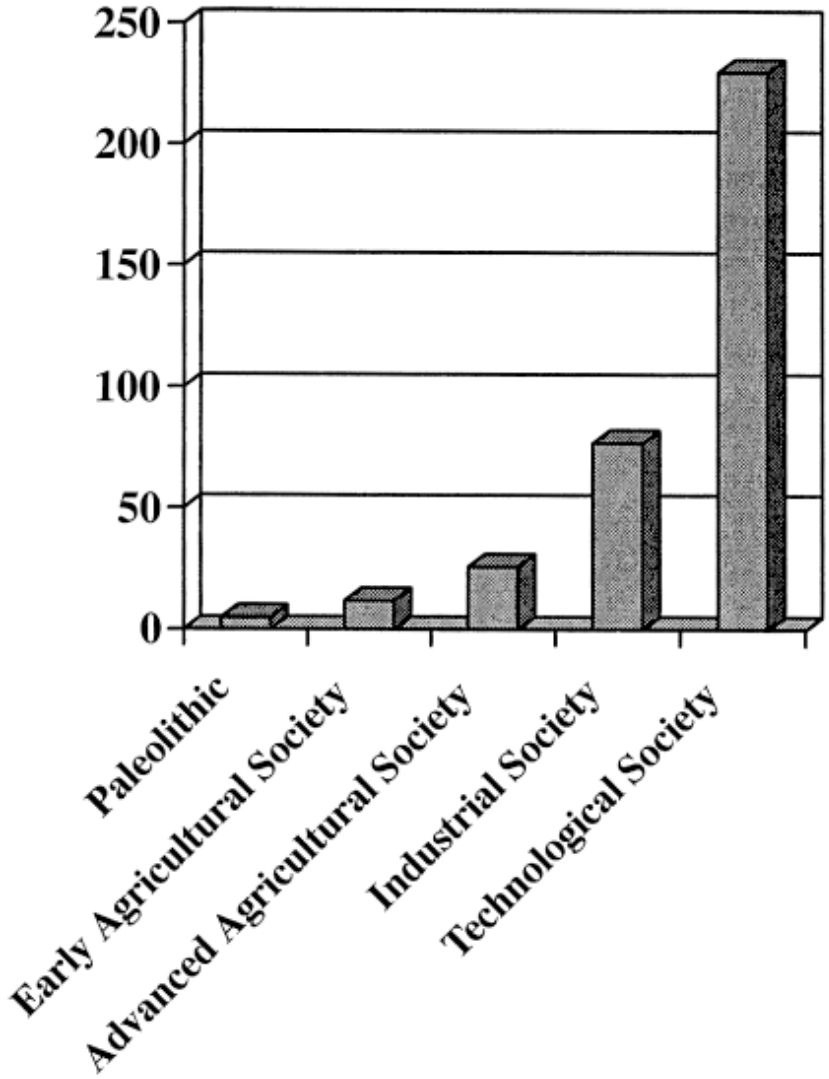
An Indian raja receives a service from a wise man and insists on repaying the favor. The wise man demurs but the raja insists. So the wise man asks for one grain of rice today, and then, for each of the next 63 days (presumably so the math-challenged raja could use his chessboard to keep track), twice as many grains as he received the preceding day.

Examples of exponential growth

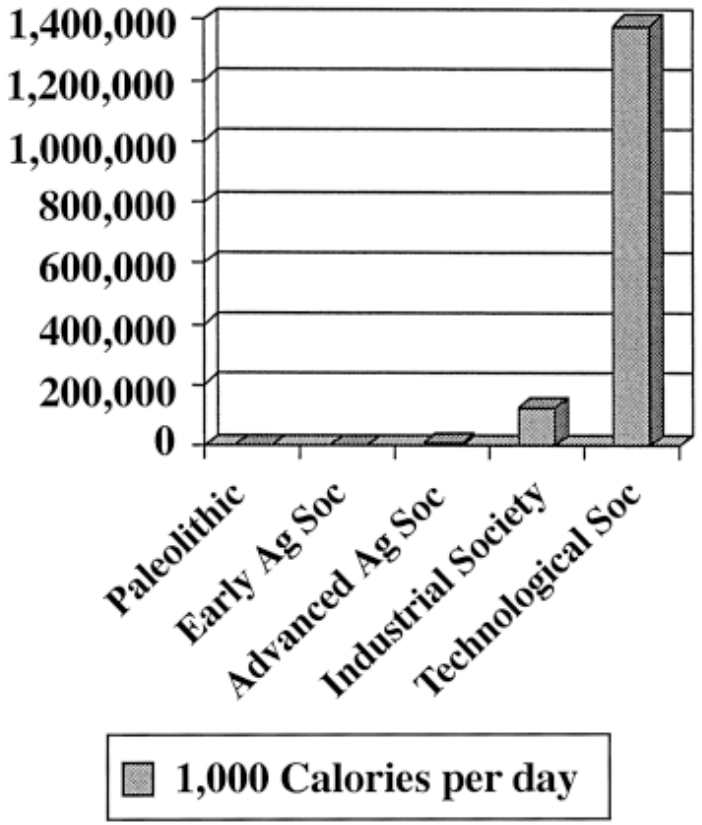
* spread of an infectious virus
* Internet traffic
* compound interest
* investment accounts (until Fall 2008!)
* nuclear chain reactions
* world oil consumption (3% / year through 2005)
* U.S. money supply (5-18% / year)
* human population (~1% / year)



Energy use per capita, by era



Total energy use by all humans, by era



David Christian, Dec 2003, Journal of World History, v. 14, no. 4.

The growth of human population parallels the growth of petroleum consumption.