Potential Intelligent Civilizations
in our Milky Way Galaxy

400,000,000,000

Sun

Illustration: NASA/JPL-Caltech/R. Hurt (SSC/Caltech)

Presenter Cues

Ask visitors, **"How many of you think we're the only intelligent life in the Milky Way Galaxy?"** Actually, we don't know, but scientists are thinking about it. Let's try to estimate the number of intelligent civilizations we might be able to communicate with. (Split visitors into 6 groups and hand each a card. *Emphasize that these are just guesses, not facts.*) Let's start with an estimate of 400 billion stars in our galaxy. But aliens won't live on stars, they'll live on planets so, Group 1…

1) What fraction of all stars in the Milky Way have at least one planet orbiting them? (f_p)
There are 4 choices here:
- *All of them* (make no changes)
- *Half of them* (cross off the 4 and write "2")
- *¼ of the stars* (cross out the 4 and write "1")
- *1 out of every 10 stars* (keep the 4 and cross off the last zero on the right)

2) What is the average number of planets that have the right environment to support life? (of the stars with planets) (n_e)
Ask why we think liquid water is necessary. (All life on Earth needs water.) <u>See key below for key to #2-6.</u>

3) On a world that has the right environment to support life, how often does *any* form of life ever develop? (f_l)
On Earth, it developed almost immediately. See the Earth Timeline for more details.

4) Once a planet has simple life, how often does that ever develop into intelligent life? (f_i)
What does your audience think the definition of intelligence is? Do dolphins care about ET?

5) How many intelligent civilizations will ever communicate over interstellar distances? (f_c)
Humans are mostly listening for potential other civilizations. Sending out signals is expensive and difficult.

6) How long will an intelligent, communicating civilization survive? (L/T_g) *How long will humans survive? Will another civilization come after us?*
<u>Ask for the *fraction of our galaxy's lifetime*,</u> found on the card

This leaves us with an estimate of the number of communicating civilizations in our galaxy right now.

Key to answers

If the answer is:	Cross off this many Zeros:
Every time/All of them	0
1 in 10	1
1 in 100	2
1 in a thousand	3
1 ten thousandth	4
1 millionth	6

So What?

If you are left with a 1 or 0, your group predicted that we are alone in the galaxy.

If you are left with a number greater than 1, it's possible that we could detect another intelligent, communicating civilization close by! But a number less than 10 implies that they are likely very far away and won't be detected soon.

Question #1 (f_p)

What fraction of all stars in the Milky Way have at least one planet orbiting them?

Astronomers are refining this estimate all the time. Data from missions like Kepler has led scientists to give a lot of information about this range. Observations show that at least 10% to more than 50% of all stars may have at least one orbiting planet. What's your estimate?

Your Guess:
- All of the stars (100%)
- Half of the stars (50%)
- ¼ of the stars (25%)
- 1 out of every 10 stars will have a planet (10%)

Question #2 (n_e)

What is the average number of planets that have the right environment to support life?

Earth is the only planet that we know has life on it. Because all life we've found on Earth needs liquid water to survive, we think water may be the key ingredient for life. There is evidence that Mars likely had liquid water on its surface in the past and there are a number of moons around Jupiter and Saturn that may have oceans under their ice sheets. As many as 5 of these worlds in our Solar System may have water and thus may be able to support life. What about worlds around other stars?

Your Guess:
- 1 out of every 10 worlds will have an environment hospitable to life
- 1 out of every 100 worlds will have an environment hospitable to life
- 1 out of every 1,000 worlds will have an environment hospitable to life

Question #3 (f_ℓ)

On a world that has the right environment to support life, how often does *any* form of life ever develop?

We only have one example of life developing at all – Earth! Simple life did develop very quickly after the oceans formed though. Does that mean it's easy for simple life to develop? Or does Earth have a very special mixture of factors (a large Moon and magnetic field, for example) that were needed for life to develop at all? We won't know unless we find other examples.

On worlds with hospitable environments, you guess:
- Simple life forms will develop every time
- Simple life forms will develop on 1 out of every 10 worlds
- Simple life forms will develop on 1 out of every hundred worlds
- Simple life forms will develop on 1 out of every thousand worlds

Question #4 (f_i)

Once a planet has simple life, how often does that ever develop into intelligent life?

We only have one example of intelligent life out of the billions of species that have existed in all of Earth's history. And it took over 3 billion years for humans to emerge. But life does seem to be increasing in complexity. If conditions are right for simple life, maybe intelligent life will inevitably appear over time. Scientists have no idea. What is your guess?

Your Guess:
- Every time
- 1 in 10 times
- 1 in 100 times
- 1 in a thousand times

Question #5 (f_c)

How many intelligent civilizations will ever communicate over interstellar distances?

Right now, humans are in the beginning stages of being able to send messages across interstellar distances. Some people think we should not broadcast that we are here at all. (Earth's TV and radio signals are too weak to be detected from even the closest stars but we have sent a handful of high-power "hello" messages across interstellar distances.) Also, what if alien intelligent civilizations lived underwater or underground and never even considered sending messages?

Your Guess:
- All intelligent life will communicate
- 1 out of 10 civilizations will communicate
- 1 out of 100 civilizations will communicate
- 1 out of a thousand civilizations will communicate

Question #6 (L/T_g)

How long will an intelligent, communicating civilization survive?

Humans have only been broadcasting a handful of messages to the stars for the last few decades. The Earth will likely be here another 5 billion years. Do you think advanced civilizations like humans will survive for millions of years, like the dinosaurs, or will we die out in a few thousand years? How much longer do you think the Earth will have any intelligent, communicating civilization on it?
(Here, tell the presenter your answer in fractions of the age of the Universe, below)

Pick one:
- 1 billion years (about **1/10** of the age of our galaxy)
- 100 million years (about **1 thousandth** of the age of our galaxy)
- 1 million years (about **1 ten thousandth** of the age of our galaxy)
- 10 thousand years (about **1 millionth** of the age of our galaxy)