
Worldbuilding
the Final Frontier
Strange new worlds; new life and new civilizations
WORLDANVIL


Who are we?
Janet & Dimi
World Anvil

Dimitris Havlidis

- Professional Worldbuilding Consultant
- Published game writer
- CTO & Founder of World Anvil, the biggest worldbuilding platform
- Fave Scifi: *Gattaca, Firefly, The Expanse, Dune, Rama*

Janet Forbes

- Professional Worldbuilding Consultant
- Published author and game writer
- CEO & Founder of World Anvil, the biggest worldbuilding platform
- Fave Scifi: *Star Trek, Expanse, The Martian, Andromeda Strain*


What is World Anvil?
Worldbuilding platform
Novel writing software
Marketing tool
Creative community
WorldAnvil

Today we're going to cover

How to

- Create new worlds, locations etc in space
- Build alien species shaped by those worlds
- Develop diverse cultures for those biological species

Our mission?

- Create intriguing settings rich with conflicts and storytelling opportunities to entrance our readers
- Tell human stories with non-human characters, and explore issues of the human condition in strange new worlds
- Have fun! :)

Astrophysics 101

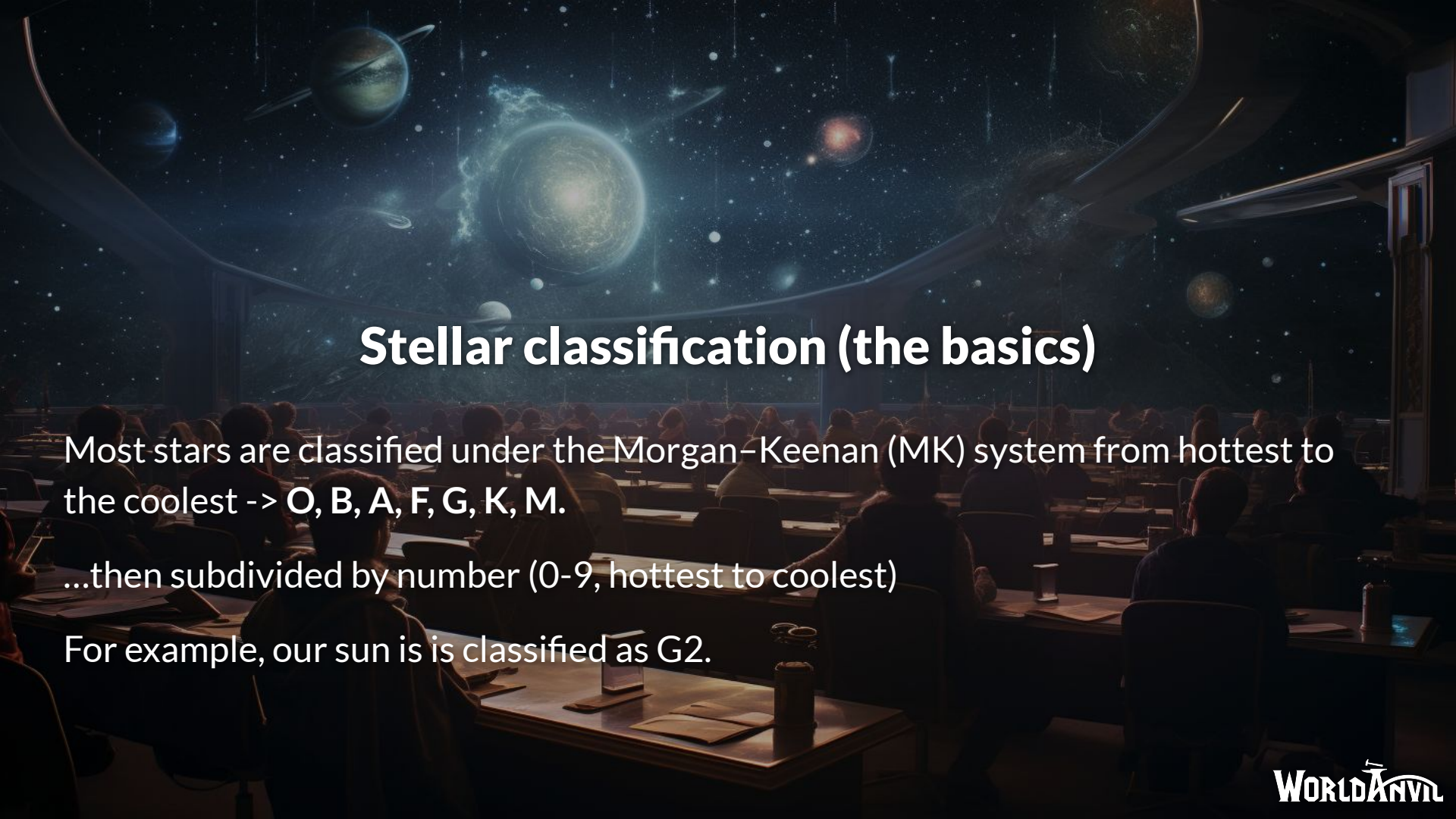
A super-quick crash course in astrogeography

Starting with the Stars

Stars are formative for their planetary systems, as well as the geography, species and cultures of those planets!

Stars can be:

- non-“planet hosting” (i.e. with nothing orbiting them - space is very empty!)
- the centre of a planetary system
- part of a star system, a small number of stars that orbit each other, which may also host a planetary system



Stellar classification (the basics)

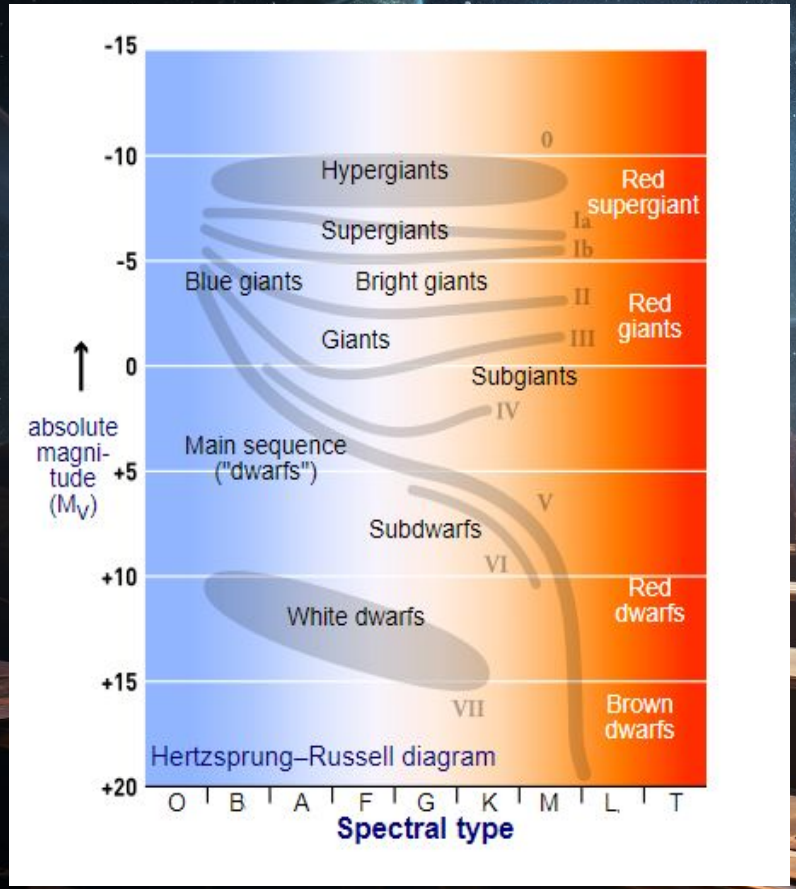
Most stars are classified under the Morgan–Keenan (MK) system from hottest to the coolest -> **O, B, A, F, G, K, M.**

…then subdivided by number (0-9, hottest to coolest)

For example, our sun is is classified as G2.

Star type, color, and prevalence of star types

Spectral Type	Color	Temperature Range	Prevalence of among Main Sequence Stars	Examples
O	Blue-violet	>30,000 K	0.00003%	Stars of Orion's Belt
B	Blue-white	10,000 K - 30,000 K	0.13%	Rigel
A	White	7,500 K - 10,000 K	0.6%	Sirius
F	Yellow-white	6,000 K - 7,500 K	3%	Polaris
G	Yellow	5,000 K - 6,000 K	7.6%	Sun
K	Orange	3,500 K - 5000 K	12.1%	Arcturus
M	Red-orange	<3,500 K	76.5%	Proxima Centauri



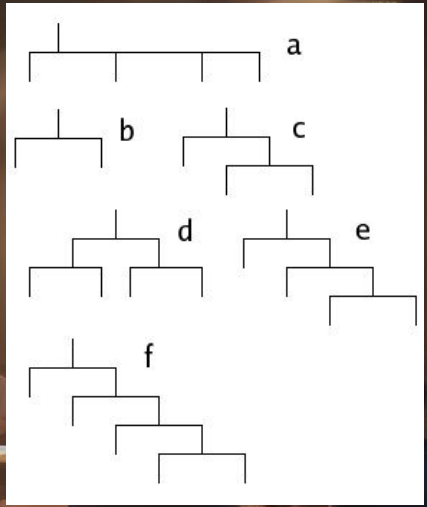
The Hertzsprung–Russell diagram

Absolute magnitude is, simply, the brightness of the star.

The lower the number, the brighter the object appears.

Making your own star systems (the cheat sheet)

- Smaller and lighter stars orbit bigger & heavier ones
- Balanced systems are usually *hierarchical*: the stars in the system can be divided into two smaller groups, each of which traverses a larger orbit around the system's center of mass
- Unbalanced systems can shoot stars off into space!



Mobile diagrams: "Stars of Higher Multiplicity", David S. Evans, *Quarterly Journal of the Royal Astronomical Society* 9 (December 1968), pp. 388 ff.


Creating your planets
Creating strange new worlds
& stellar phenomena
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What is a planetary system?

- Non-stellar objects (i.e. planets, comets etc.) which orbit a star, or star system
- Formed from protoplanetary disks (gas and dust that surrounds a newly formed star)

Can contain:

- Planets, Satellites/Moons & Planetesimals (minute planets)
- “Circumstellar disks” (like the Oort cloud, Kuiper Belt, Asteroid Belt)
- Asteroids
- Comets

What kinds of planets can you create?

Gas giant

- giant planet composed mainly of gaseous helium and/or hydrogen, e.g. Jupiter, Saturn
- no hard surfaces

Neptunian

- around the size of Neptune or Uranus
- typically core of rock & heavier metals, hydrogen & helium dominated atmospheres
- “mini-Neptunes” are also now being discovered

Super-Earth

- 3-10x the mass of Earth, but smaller than Neptunian
- may include a wide variety of surface types: water worlds, snowball planets, etc.

Terrestrial

- 0.5 -2x the radius of Earth, e.g. Mars, Mercury & Venus
- smaller, rocky planets
- generally dominated by rock or iron, and a solid or liquid surface

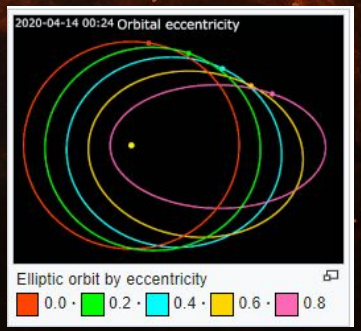
Average of 10 planets per planetary system (but may be few or many)

Goldilocks Zone: “About half the stars similar in temperature to our Sun could have a rocky planet capable of supporting liquid water on its surface.” (NASA, 2020)

Making choices that affect your planets

- The closer to the star, the warmer the planet
- Planets closer to the sun also move faster through their orbits (shorter years)
- Faster spin = shorter day. Spin also influences winds & cloud formation.
- Durations of Day/Night and Year
- Axial Tilt (seasons)
- Orbital Eccentricity and Elliptical Orbits equals Seasonal Inequality

When the orbit is eccentric, seasons during the time the planet is furthest from the sun are abnormally long
(Aphelion / Perihelion / Orbital)

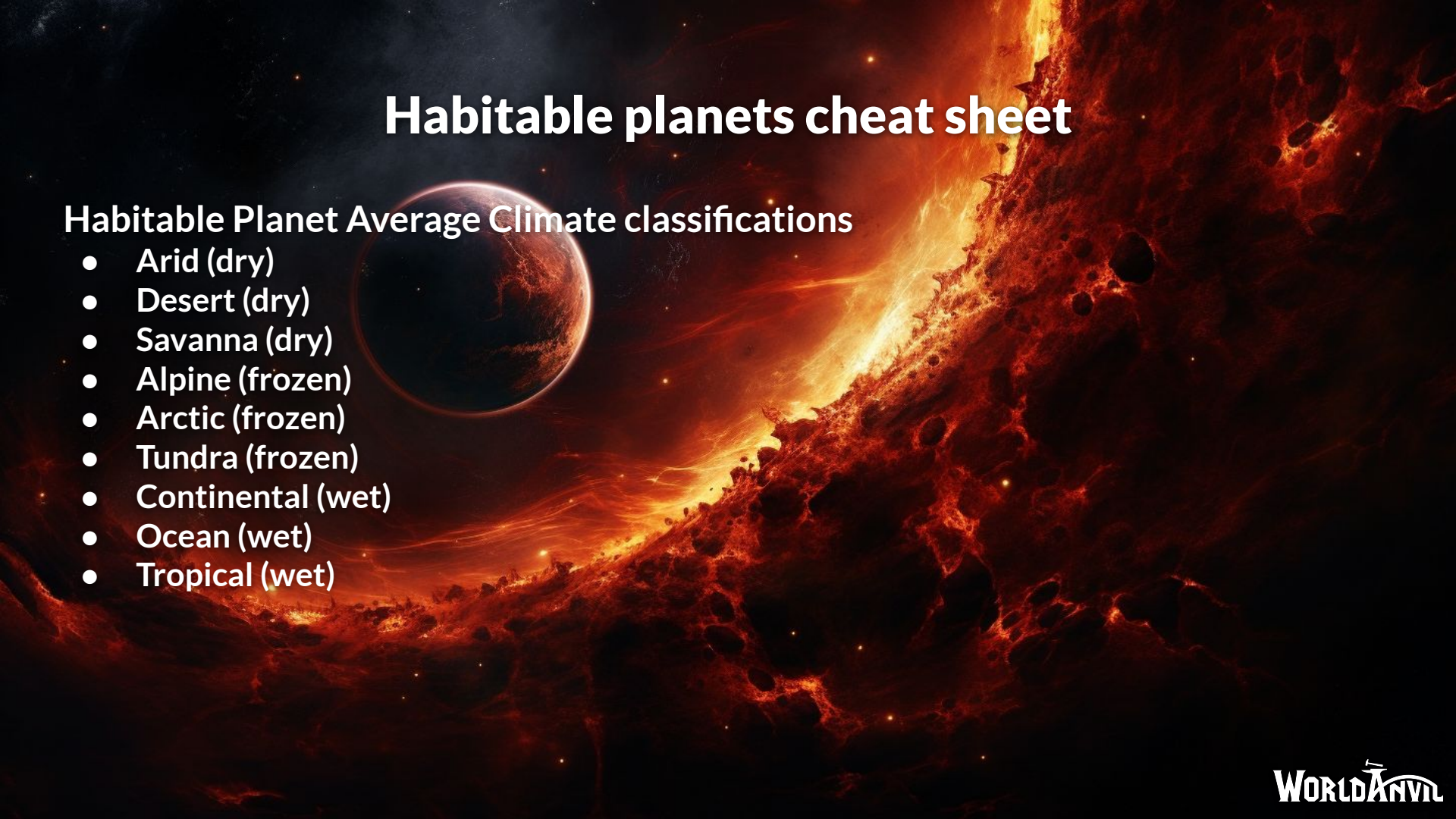


The GRAPH system for describing planets

G.R.A.P.H. is useful, quick system for determining surface conditions of a planet, used in many RPG games (Alternity, Traveller etc).

- Gravity: determined by a planet's size and mass
- Radiation: cosmic (may be shielded by atmosphere) & native radioactive elements
- Atmosphere: (composition / escape velocity*/ Albedo)
- Pressure [Atmospheric] : literally the “weight” of the atmosphere at surface level
- Heat: surface temperature variation, day/seasonal variations - dependant on distance to the sun & orbit

Habitable planets cheat sheet



Habitable Planet Average Climate classifications

- Arid (dry)
- Desert (dry)
- Savanna (dry)
- Alpine (frozen)
- Arctic (frozen)
- Tundra (frozen)
- Continental (wet)
- Ocean (wet)
- Tropical (wet)

Other kinds of planets & conditions/tropes

Mainly uninhabitable (or are they?!) *Locations for pirates, rebel bases, outposts etc.*

- Asteroid (Rock/Ice)
- Barren
- Frozen
- Gas Giants
- Molten Rock planets
- Toxic / Radioactive locations

<u>Planetary tropes/conditions</u>

• Rogue planets	Planets independent of a planetary system (these really exist!)*
• Broken planets	Planets destroyed at some point the past; broken, somewhat spherical ruins
• Gaia planets	Idyllic, habitable eden-like
• Tomb worlds	Barren, lifeless planets, homes to a civilization long gone
• Ecumenopolis	Planet-wide cities (e.g. Coruscant in *Star Wars*)
• Relic	As tomb worlds, but filled with still live Technology
• Machine planets	Remanufactured with all their resources used as infrastructure by Robots (The Matrix)
• Shielded planets	Planets entombed by an Energy shield (nobody in - nobody out)
• Shrouded planets	Mostly hidden/phasing in and out, hidden in a nebula

*Interstellar planets of FFPs (free-floating planets) generate little heat and are not heated by a star. However, in 1998, David J. Stevenson theorized that some planet-sized objects adrift in interstellar space might sustain a thick atmosphere that would not freeze out. He proposed that these atmospheres would be preserved by the pressure-induced far-infrared radiation opacity of a thick hydrogen-containing atmosphere. In an Earth-sized object the geothermal energy from residual core radioisotope decay could maintain a surface temperature above the melting point of water.

More prompts for creating planets?

- geographical features?
- climate & weather?
- ecosystem?
- localized phenomena?
- resources?

All these (and more), expanded and with definitions and examples, in the geography worldbuilding template on World Anvil

Sci-Fi mega-structures that affect worlds

- **Habitat/Starbase/Star Cities** (construction, e.g. DS9)
- **Gateways**
- Ringworld (1970, Larry Niven): an artificial ring that circles the sun
- **Dyson Sphere or Dyson Swarm** (theorised by Freeman Dyson): a hypothetical megastructure, or swarm of small structures, that encompass a star to capture solar power
- **Quantum catapults**

More prompts for creating Megastructures?

- Purpose?
- Structure?
- Construction date & owner?
- History?
- Secrets

All these (and more), expanded and with definitions and examples, in the building/landmark worldbuilding template on World Anvil


Building aliens...
Simple methods for developing interesting peoples (both alien and human)
moulded by exotic environments
WorldAnvil

Sapient vs. Sentient

“Non-Sentient” species are unable to experience emotions or consciousness. Generally includes fungus, plants, microbes, some animals etc.

“Sentient” is the ability to feel or perceive, allowing to think and experience emotions. This would necessarily include consciousness. Includes (arguably) animals.

“Sapient” is the capacity for intelligence, wisdom, and logic along with the ability to solve problems, learn, and understand. Often called “intelligent life”.

Definition of life?

- What life is, and how life looks, is a fluid concept.
- You could have hydrocarbon, silicon, or phosphorus-based lifeforms (all can create chains, which means they could potentially create proteins)
- The envelope is continuously being pushed in terms of how we understand life (cfr viruses, sulphurous bacteria in undersea vents, tardigrades!).

How strange is too strange? (a.k.a. choose your complexity)

What kind of story do you want to tell?

Humanoids vs. Non-Humanoids

- Humanoid
- Machine
- Mammalian
- Reptilian
- Avian
- Arthropoid
- Molluscoid
- Fungoid
- Plantoid
- Lithoid
- Necroid
- Aquatic

Limitations of TV (human-suits)

Watching the tropes:
Space goblins and Vampire Space Elves

GRAPH: Gravity when Creating Alien Species

Animal Size: high gravity reduces the size of creatures

Muscle strength, bone density/composition: stronger bones and muscles required to withstand higher gravity

Hydrodynamics of circulation: high-gravity species require especially strong cardiovascular systems

Flight capabilities: low-gravity species will find jumping, running, gliding and flying easier!

Gravitropism: the ability to perceive and respond to gravity

Aquatic vs. land animals: the effect of buoyancy vs. gravity (cfr blue whales)

Single celled organisms: gravity imposes an ultimate size limitation

GRAPH: Radiation when Creating Alien Species

Radiation = energy (waves or particles)!

Cosmic radiation: from solar flares and from outside the solar system (high-energy protons and heavy ions). Atmospheres may filter (e.g. Ozone layer)

Native radiogenic isotopes:

- Can be present from the formation of the planet or asteroid bombardment (or produced artificially)
- Can be helpful! Radioactive potassium, uranium and thorium are thought to be the three main sources of heat in our planet's interior

Species growing up in radioactive environments might:

- Evolve faster due to cellular mutations
- Develop biological defenses (e.g. dermal protectives like melanin/shells)
- …or behavioural defenses (e.g. live underground)
- They may be able to perceive some types of radiation but not others
- Could be radiotrophic (receive energy from radiation)

GRAPH: Atmosphere when Creating Alien Species

How is our atmosphere used? (78% Nitrogen, 20% Oxygen, 0.9% Argon, 0.035% Carbon dioxide)

- By humans: O2 is used to create energy in the mitochondria.
- By plants: CO2 is 'fixed' - i.e. used directly for plant growth
- By nitrogen-fixers (bacteria/fungi): N2 => NH3 (Ammonia)

The anatomy of breathing:

- Lungs (terrestrial)
- Gills (aquatic)
- Spiracles (insects: limitations on size vs. oxygen-richness)

Combustion: requires an oxidizer like oxygen, fluorine, chlorine. Too much and a lightning strike can set the atmosphere on fire.

Atmospheres can change! Through volcanic activity (which first formed Earth's atmosphere), flourishing life (e.g. the creation of additional oxygen in our atmosphere through algae!), and sapient intervention (e.g. global warming)

GRAPH: Pressure when Creating Alien Species

At low atmospheric pressures (e.g. high altitudes):

- it's harder to extract Oxygen from the air because there are fewer molecules per m^3.
- More efficient processes are required (can be developed over time by humans)

Changing barometric pressures can be catastrophic to humans…:

- Ear popping
- The "bends", or "divers disease"

GRAPH: Heat when Creating Alien Species

Cold worlds: Fur, feathers, fat, large volume with small surface area

Hot worlds: skin flaps, sweat, shells, large surface area with smaller volume, crepuscular or nocturnal behaviours, tree-dwelling or burrowing

Seasonal changes: moulting, changing color, hibernating, diet, emigrating, mating practices,

Environmental Effects: sand/snow storms, availability of water/food, stellar phenomena (e.g. solar flares, Thread etc.)

More prompts for creating Alien Species?

- Anatomy & morphology
- Perception & extrasensory capabilities
- Genetics & reproduction
- Growth rate & stages
- Ecology & habitat
- Dietary needs & habits

All these (and more), expanded and with definitions and examples, in the species worldbuilding template on World Anvil


Developing Alien Cultures
Building cultures beyond biology
WorldAnvil

Technology levels

Importance of Energy: The Kardashev Scale / Moore's law

Branches of Technology

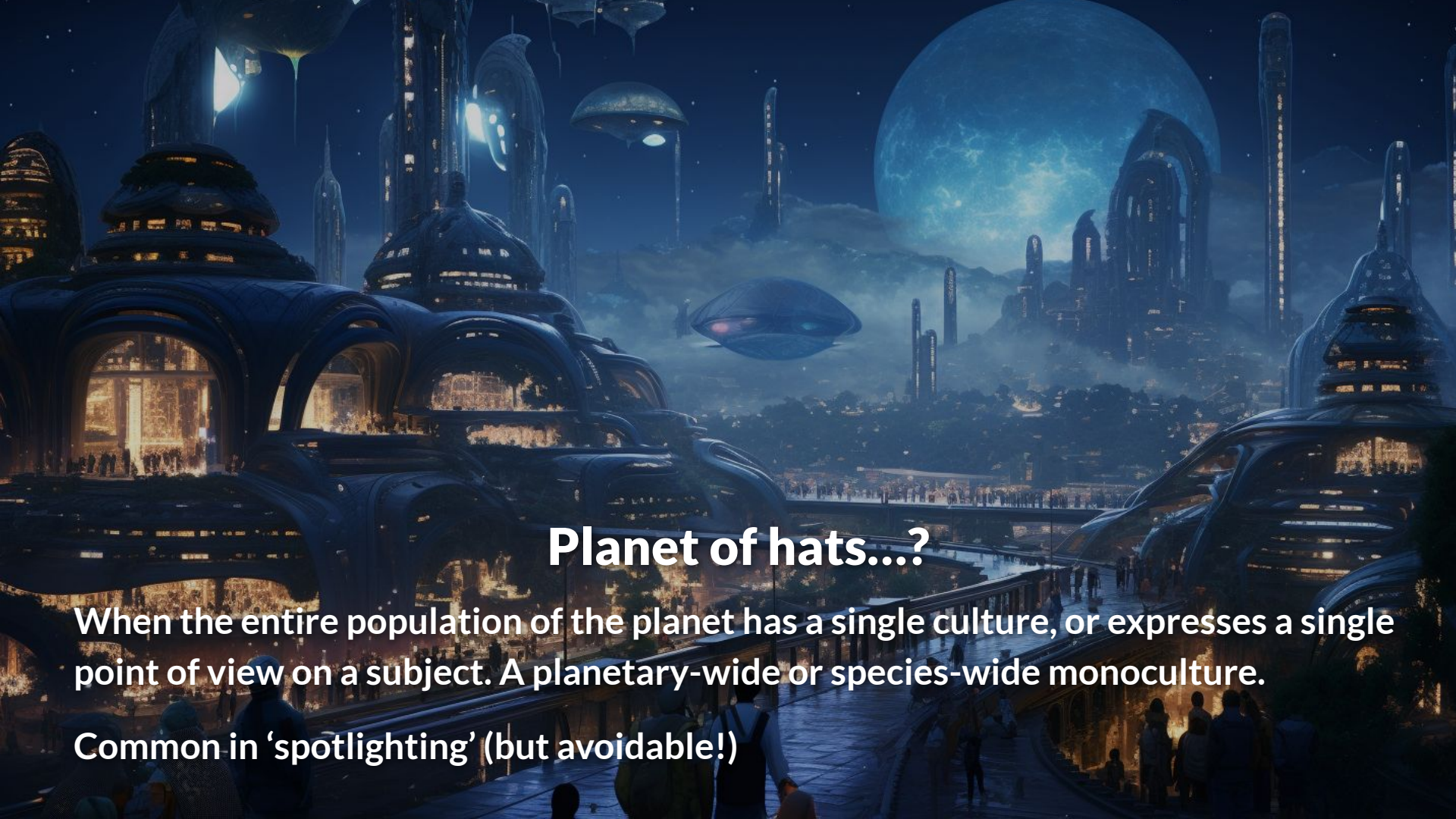
- Biology: Agriculture, Medicine, Genetics, Bioweapons, Cloning
- Physics: Lasers, Shields, Anti-Gravity
- Engineering: Robotics, Armor, Projectiles, Missiles
- Informatics: Computing power, AI, etc.

Common Trope: which branch of technology has this culture/species focussed on? E.g. Kaminoan cloners (Star Wars), Moklan weapons experts (Orville), espionage-focussed Romulans (Star Trek)

Milestones: Which “major secrets” have they unlocked? (Dark Matter Manipulation, Meta materials, Unified Theory, Creation of Life, Psionics, Transcendence)

FTL travel/communication?: travelling outside “normal” space (Warp Drive, TNG), instant teleportation (Jump Drive, BSG), ditto but through jump gates (stargate), wormholes, Slipstream along “strings” (Andromeda). First contact.

Janet’s holy triangle of technology/magic: Power (what can it do?) vs. Cost (what does it require?) vs. Limitations (what can’t it do/what stops it?)



Planet of hats…?

When the entire population of the planet has a single culture, or expresses a single point of view on a subject. A planetary-wide or species-wide monoculture.

Common in ‘spotlighting’ (but avoidable!)

…Or NO planet of hats!

Within a single species, you show different cultural groups. This is reflective of how humans work. Cultures can be formed and affected by:

- External factors, like climate, weather, resources
- Biological factors
- Inherited history and origin
- Internal factors, like religion and politics (e.g. N. vs. S. Germany)

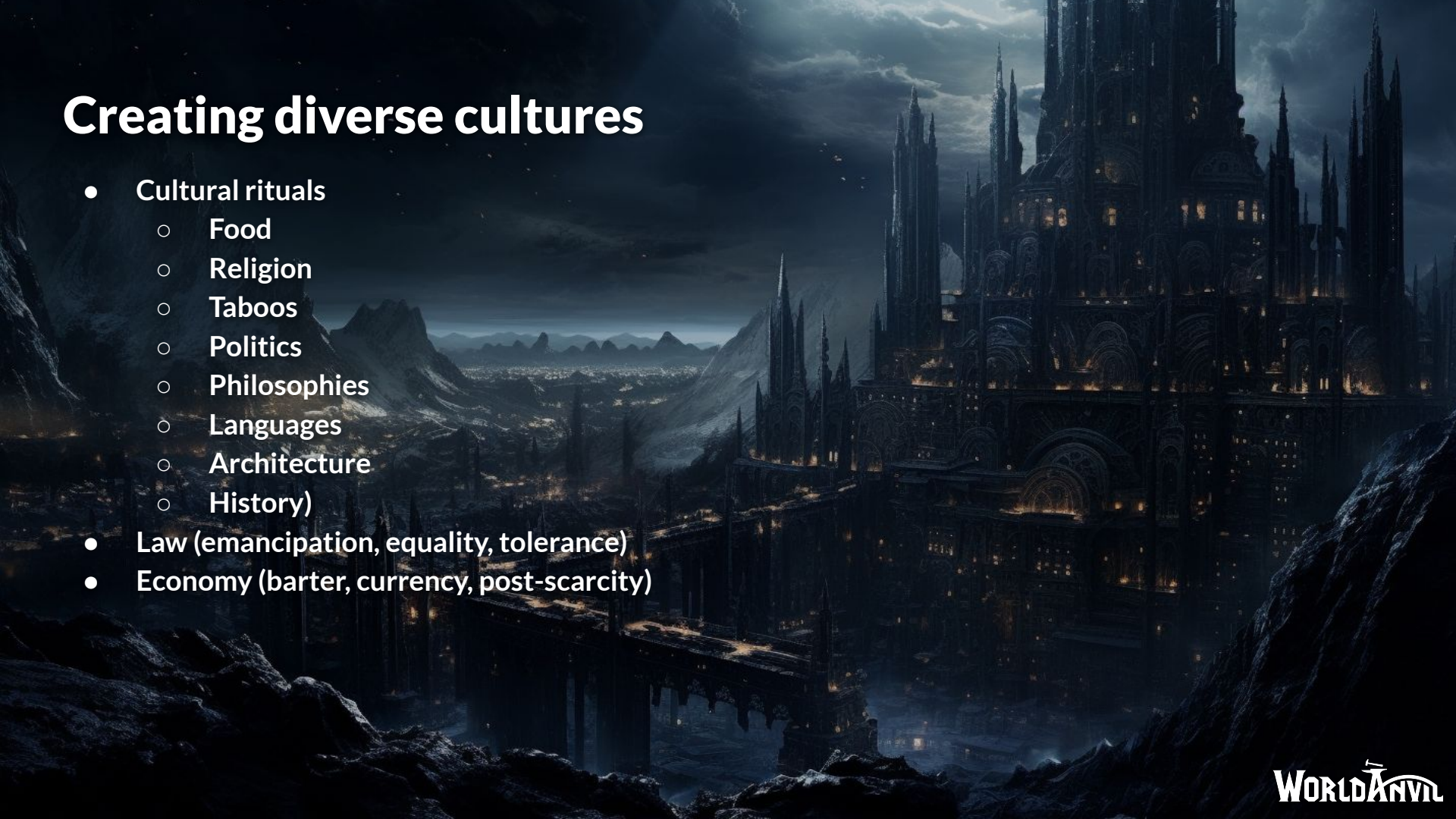
Consider that because of their biological make-up:

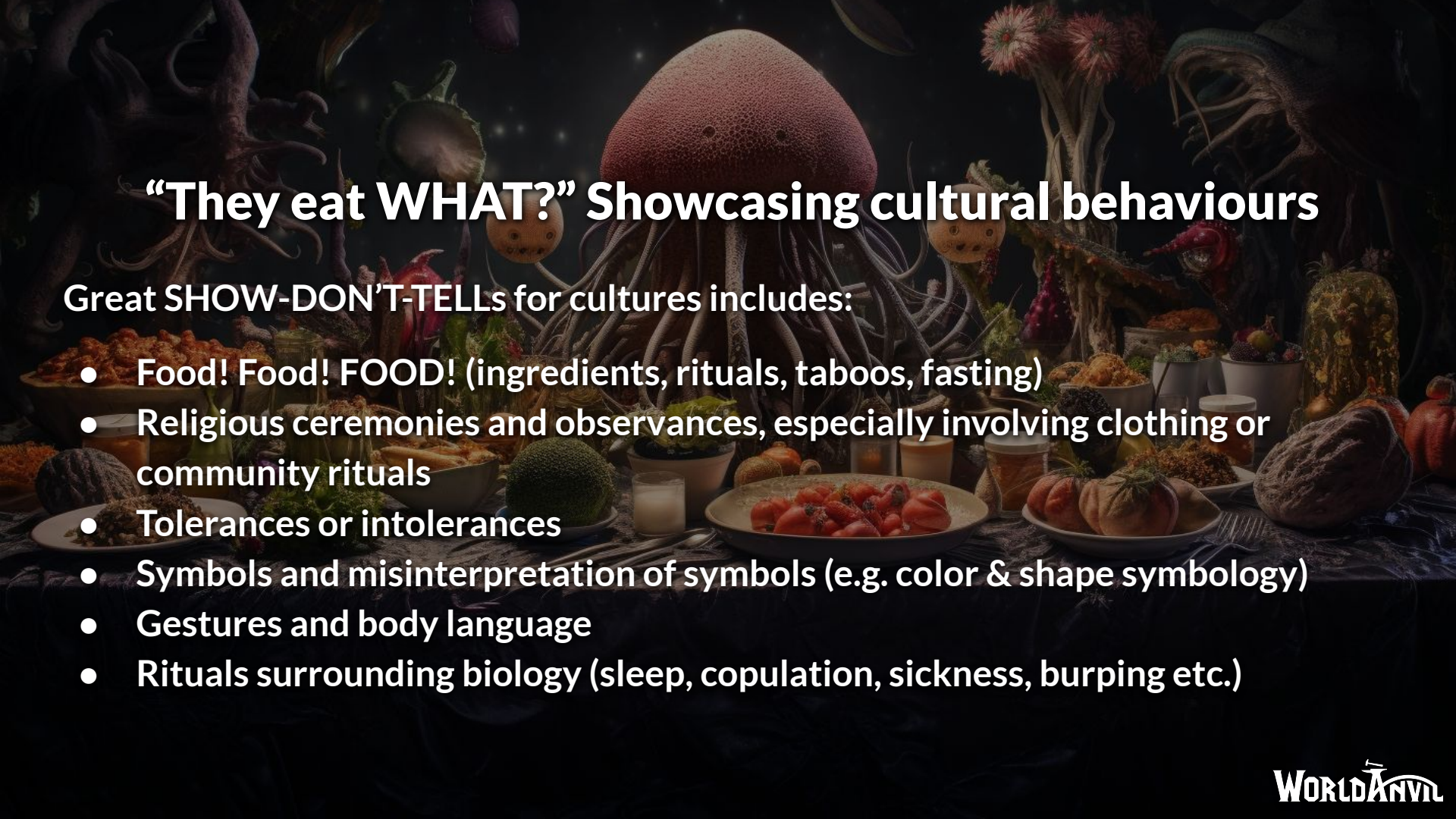
- there will be biological truths (e.g. birth, death, procreation, old age) that are interpreted and handled different by different cultural groups
- there will be unifying factors that define the species to those not part of these groups

E.g. Pon Farr, development of additional capabilities (Kes, Saru)

Creating diverse cultures

- Cultural rituals
  - Food
  - Religion
  - Taboos
  - Politics
  - Philosophies
  - Languages
  - Architecture
  - History)
- Law (emancipation, equality, tolerance)
- Economy (barter, currency, post-scarcity)





“They eat WHAT?” Showcasing cultural behaviours

Great SHOW-DON’T-TELLs for cultures includes:

- Food! Food! FOOD! (ingredients, rituals, taboos, fasting)
- Religious ceremonies and observances, especially involving clothing or community rituals
- Tolerances or intolerances
- Symbols and misinterpretation of symbols (e.g. color & shape symbology)
- Gestures and body language
- Rituals surrounding biology (sleep, copulation, sickness, burping etc.)

More prompts for creating Alien Cultures?

- Naming traditions
- Shared taboos and codes
- Genders & gender ideals
- Courtship & relationships
- Fashion, art, architecture
- Rites of passage / milestone customs

All these (and more), expanded and with definitions and examples, in the Culture worldbuilding template on World Anvil


Thank you for listening!
Any questions?
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