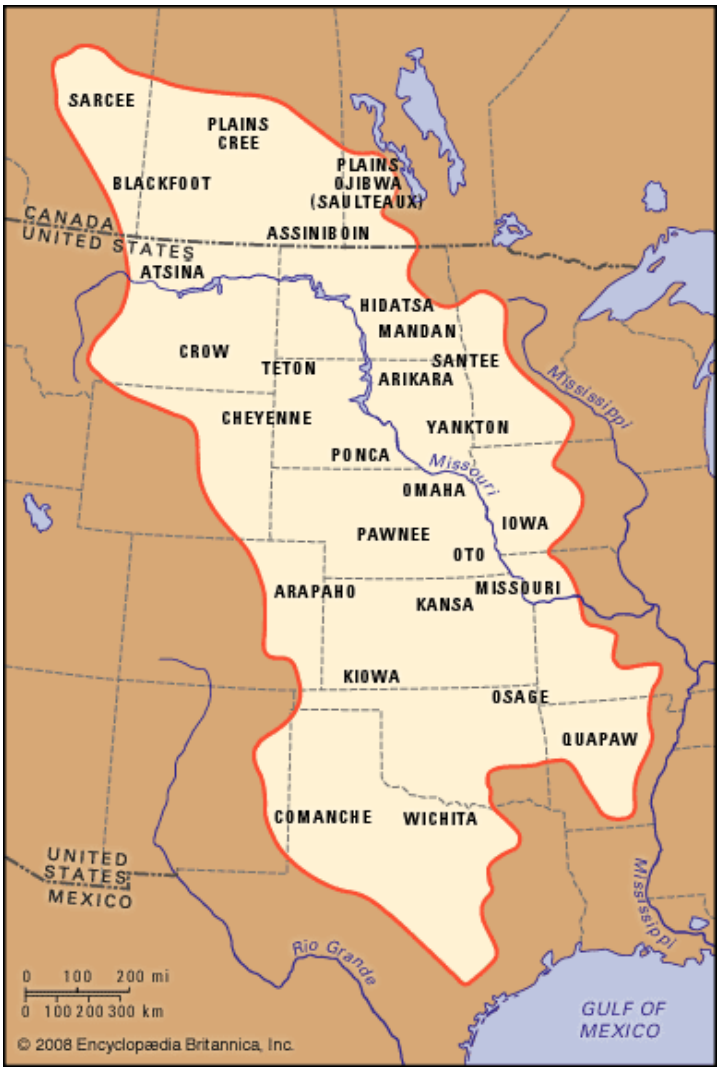
Plains Indians Foodways

Overview of the Plains Indians

The Plains Indians (aka Indigenous people of the Great Plains and Canadian Prairies), similar to the Inuit, are descended from people who migrated across the Bering Strait to Alaska between 50,000-17,000 years ago. Humans expanded from Alaska into Canada, and later into the United States, around 15,000 years ago, and the Plains Indians' most recent ancestors, known as the Clovis people, arrived around 13,100-12,900 years ago. Though, it should be noted that there are conflicting data in this regard, with some data suggesting that Indians and their ancestors may have been in the plains for at least 38,000 years, prior to the arrival of the Clovis (Lovgren, 2007). Evidence from eastern Wyoming's Agate Basin site indicate that humans lived in the Plains as early as 8500 BC (*Encyclopedia of the Great Plains Indians*, 2007)(p.2). Additionally, mitochondrial DNA suggests that four distinct genetic lineages appeared in the western hemisphere between 37,000 and 33,000 years before present. All contemporary Native Americans are descended from these lineages (*Encyclopedia of the Great Plains Indians*, 2007)(p.145).



The Plains Indians represent a wide variety of indigenous people living in the central part of the United States and Canada, with most living east of the Rocky Mountains. There are six distinct American Indian language families represented by the Plains Indians. Groups of Indians who speak the same language are often referred to as a tribe or nation; however, referring to a group as a 'tribe' or 'nation' based on their language doesn't mean that they are part of the same political group. For example, the Blackfoot tribe includes three independent bands, the Blackfoot proper (Northern Blackfoot), the Blood, and the Piegan (Prine Pauls, 2018).

The Plains Indians' initial contact with Europeans occurred around 1598, when the Spanish settled in New Mexico. At that time, horses were introduced into Plains Indians culture; however, widespread diffusion of the horse didn't happen until after 1680. While the Plains Indians had some

contact with Europeans in the late 17th and early 18th centuries, regular, direct contact didn't occur until around the 1830s, when fur traders, artists, and explorers infiltrated the Great Plains. The Oregon Trail opened in 1840, resulting in the U.S. government's greater involvement in Plains Indians' affairs. Overall, greater contact with Europeans and the U.S. government gradually wore away at the Plains Indians' autonomy, reducing the amount of land on which they were able to live and survive, and their eventual removal to infamous Indian reservations (Prine Pauls, 2018).

General societal structure. Societal structure varied by tribe due to a combination of pre-contact experiences, adaptation to the plains, and responses to white contact. After European contact, many egalitarian tribes changed as they became more commercially oriented, with the social hierarchy depending on ownership of goods, and horses in particular (Carlson, 1998)(pp.67-70). In general, the Plains Indians valued individual competency and honoring obligations to the community. For example, generosity to the poor, sharing with relatives, and being hospitable and cooperative were valued and raised the status of the individual or family (Prine Pauls, 2018). (Luke-Please let me know if you want me to go into more detail on councils, the 'election' of chiefs, etc. There is much more information if desired!)

Nomadic tribes. Nomadic tribes tended towards egalitarian societies. The only time nomadic tribes exercised sociopolitical controls was during the summer, when the larger populations (due to summer hunts) required tighter constraints. During the rest of the year, nomadic Plains Indians lived in small bands, whose smaller populations needed fewer sociopolitical controls. Bands represented economic, social, and political units; however, band membership was fluid and people typically had relatives in other bands. Family members could shift band alliances and, if bands became too large, some families left to form a new band. They also created new bands whenever conflicts within bands were so bad that the only solution was to split the original band. For these reasons, band structure and names changed (Carlson, 1998)(p.67).

Bands that joined together during the summer were known as tribes. When bands united, they held tribal meetings, ceremonies, and communal hunts to solidify tribal identity. When tribes were fractured into bands, they maintained their tribal identity through common language, tradition, and histories. Some tribes, like the Crow or the River people, had organizations known as moieties. These were two halves represented a sociopolitical organization where the group split in two complementary units, each having separate systems of headmen and councils. Some groups required that a man marry outside his moiety, though this wasn't always the case. Most nomadic tribes had a bilateral system in which descent was traced through both the mother and father (Carlson, 1998)(pp.67-69).

Semi-sedentary tribes. For semi-sedentary Plains Indians, the social and political organization centered in villages or clans. Clans were Indians whose lineage descended from a common ancestor, often tracing back for generations. Heredity often determined clan membership and this could cut across village boundaries. Head men from prominent lineages were often clan representatives and made up councils that governed villages and allied towns that comprised an ethnic community or tribe. Some clans were so large that not all clan families lived or traveled together. Despite this, clansmen believed they were obligated to protect fellow clansmen in battle

and to share the moral responsibility of other clansmen's wrongs. There were both patrilineal and matrilineal clans. Matrilineal clans were common among clans where women controlled food cultivation (like the Wichitas, Mandans, and Hidatsas). Patrilineal clans may have resulted from increased warfare or may have descended from patrilineal chiefdoms of the Mississippian times. Patrilineal clans included the Omahas and other Dhegihal-speaking groups (Carlson, 1998)(pp.68-69).

Chiefdoms?. Some societies organized into a structure similar to that of chiefdoms, in which rank was particularly important and the chief was the central authority figure. Chiefs often had little political power but represented the social and economic head of the community, which became important, for example, when needing to distribute surplus food. Examples of semi-chiefdoms include the Chinook, Salish, and other Northwestern coastal groups. No true chiefdoms existed because bands and tribal groups continued to maintain essentially democratic sociopolitical structures (Carlson, 1998)(pp.69-70).

Clothing. The tools used for dressing skins, both for clothing and for tipis, were made from bone, antler, and horn, and they used bone awls to punch holes in the hides for sewing (Carlson, 1998)(p.54). During the summer, men wore a breechclout held into place with a rawhide belt, leggings attached to the belt, and moccasins. Southern Plains Indians often left their upper body bare and tattooed their chest, shoulder and arms (Prine Pauls, 2018).The type of moccasin depended on the region. Southern tribes wore two-piece moccasins made from buckskin uppers sewn to a stiff sole of tanned bison hide. Northern tribes wore one-piece, soft-soled moccasins. Leggings sometimes had long fringes or were ornamented with beads or other items. After white contact, the Plains Indians adopted European-made items, like metal bells, as part of their clothing. During the winter, men wore bison robes, knee-length boots made from bison hide and lined with hair, and shirts made from deer, sheep, or pronghorn skins. Northern people wore fur beaver caps and mittens. Southern plains women wore ponchos and a wrap-around skirt (Carlson, 1998)(pp.63-64). Other women wore a long dress with leggings that reached to the knee and moccasins (Prine Pauls, 2018). Ceremonial dress was much more elaborate than daily attire. This included things like headdresses and elaborately decorated war shirts (Carlson, 1998)(pp.63-64). Decorations included porcupine-quill embroidery, fringe work, and the eyeteeth of elk. After European contact, beading was added as decorations (Prine Pauls, 2018).

The traditional Plains Indian diet

The traditional Plains Indian diet primarily included bison meat and plant-based foods, including corn, beans, sunflowers, squash, and pumpkins. They also used wild fruits and berries, wild vegetables, collected nuts, and dug roots and tubers. Other animal-based foods they consumed included deer, black bears, elk, rabbits, ducks, and game birds. Some tribes gathered wild rice and other tribes ate foods like rose hips, milkweed buds, and thistle stalks. Southern tribes ate the fruit of prickly pear cactus, adding it to soups and stew. Depending on the tribe, other animal-based foods, like turkeys, dogs, horse, snakes, etc. were eaten, but there were also food taboos in particular tribes (Carlson, 1998)(pp.54-55). (see Religious Beliefs)

Animal-Based Foods.

Half of their food needs were supplied by animal-based foods, particularly the bison, though they also consumed other animals, as listed below (Haines, 1976)(p.18).

Bison. Not surprisingly, the Plains Indians ate almost all parts of the bison, including raw kidneys, tallow around the kidney, loin tallow, and the paunch. Curdled milk from the stomach of a bison calf or fawn was also consumed. Fresh liver sprinkled with bile from the gall bladder was considered a delicacy. Some sources suggest that bison comprised around 90% of the animal-based foods used by northern tribes, such as the Blackfoot (Wood, 1998).

Fish. Salmon were important for Northern Plains tribes during the spring, when the salmon swam upstream to spawn (Schlesier, 1994)(p.144).

Water-based foods. Northern Plains Indians hunted migratory waterfowl during the spring and fall (Schlesier, 1994)(p.144). Other Plains Indians also hunted migratory birds and ate freshwater mollusks (Schlesier, 1994)(p.209).

Other animals. Plains Indians also ate deer, elk, antelope, turkey, black bears, beavers, rabbits, etc. These types of animals were more important in certain regions, like the Northern Plains, where the bison populations were smaller.

Plant Foods. The Plains Indians used more than 120 native prairie plants for foods. They used plants for seasonings, tea, or to meet nutritional needs, such as eating greens in the spring to prevent scurvy. In regions were bison were rare, plant foods were more important. Berries and roots were particularly important. About half of their total food need were met by gathering and cultivating plant-based foods (Haines, 1976)(p.18).

Gathered foods.

Tubers and roots. The prairie turnip (*Psoralea esculenta*) was the most important native plant food. The prairie turnip is a starchy root and was eaten as a staple food or added to stew. They also dried, stored, or traded the prairie turnip (*Encyclopedia of the Great Plains Indians*, 2007)(p.156). Prairie turnips have a mild, earthy flavor when fresh (Stahnke et al., 2008) and a slightly sweet taste when pulverized (Kaye & Moodie, 1978). Other tubers included the prairie bulrush (*Scorpus paludosus*) (Johnston, 1970), Indian potato (*Glycine apios*), and Jerusalem artichoke (*Helianthus tuberosus*) (Gilmore, 1919)(p.59, p.105).

Roots consumed included camas (*Cammassia quamash*), bitterroot (*Lewisia rediviva*), biscuit root (*Lomatium* sp.), squaw-root (*Perideridia gairdneri*), bistort (*Polygonum bistortoides*), great bulrush (*Scirpus acutus*), silverweed (*Potentilla anserine*), Canadian milk vetch (*Astragalus canadensis*), arrow-leaved balsamroot (*Balsamorhiza sagittata*), white thistle (*Cirsium hookerianum*), and the wild artichoke (*Helianthus maximilianii*) (Johnston, 1970; Kaldy, Johnston, & Wilson, 1980). They also ate a variety of water-plantains including *Sagittaria cuneate, Sagittaria latifolia* (Arrow-leaf), and yellow lotus (*Nelumbo lutea*) (Gilmore, 1919; Johnston, 1970).

They ate wild onions, like the nodding onion (*Allium cernuum*) and a generically named wild onion (*Allim mutabile*), the spring lily (*Erythronium mesochoreum*), and the bulbs of the mariposa lily (*Calochortus apiculatus*), the glacier lily (*Erythronium grandiflorium*), and yellow-bell (*Fritillaria pudica*). They ate the corms of western spring beauty (*Claytonia lanceolate*). They ate the stalks of cow parsnip (*Heracleum lanatum*) and two varieties of prairie parsley (*Lomatium simplex* and *triternatum*) (Johnston, 1970).

<u>*Fruits and berries.*</u> Fruits include wild grapes (*Vitis cinerea, V. vulpine*), persimmon, hawthorn (*Craetaegus douglasii*), wild strawberries (*Fragaria virginiana*), wild red raspberries (*Rubus strigosus*), wild plums, sumac, chokecherry, ground cherry, and passionflower (Drass, 2008; Gilmore, 1919). They ate fairy-bell berries (*Disporum trachycarpum*), creeping mahonia berries (*Berberis repens*), Saskatoon berries (*Amelanchier alfniolia*), bearberries (*Arctostaphylos uva-ursi*), bilberries (*Vaccinium membranaceum*), hackberries (*Celtis occidentalis*), chokecherries (*Padus nana*), ground cherry (*Physalis heterophylla*), elder berry (*Sambucus canadensis*), nannyberries (*Viburnum lentago*), and the thorny buffalo-berry (*Shepherdia argentea*). Depending on where they lived, some Plains Indians ate the fruit and/or stems of cacti. For example, the Blackfoot ate the ripe fruit of the ball cactus (*Mamillaria vivipara*) (Johnston, 1970). Prickly pear fruit (*Opuntia humifusa*) was also consumed (Gilmore, 1919)(p.71). Some

<u>*Fungi, Algae, and Lichen.*</u> Plains Indians ate fungi, though consumption varied by tribe and many fungi were only used for medicinal purposes. The Blackfoot Indians ate a variety of fungi, including fairy ring mushrooms (*Marasmius oreades*), stone fungus or Indian bread (*Polyporus tuberaster*), puffballs (*Lycoperdon*), tree ear mushrooms (*Polystictus versicolor*), corn smut (*Ustilago maydis*), morels (*Morchella esculenta*), and oyster mushrooms (*Pleurotus ulmarius*) (Gilmore). They also ate moss, particularly tuck (*Alectoria fremontii*) which was a famine food (Johnston, 1970).

<u>*Other gathered foods.*</u> They gathered black walnuts (*Juglans nigra*), hickory nuts (*Hicoria ovata*), hazelnuts (*Corylus Americana*), amaranth, purslane, ragweed, ground beans (*Falcata comosa*) (Gilmore, 1919)(p.60). Indians ate milkweed (*Asclepias syriaca L.*) (Gilmore p.79). They ate some grasses, leaves, and tree barks. The tree bark they ate included white-bark pine (*Pinus albicaulis*), western red cedar (*Thuga plicata* D. Don.), and the inner bark of young sprouts of cottonwood trees (*Populus sargentii*) (Gilmore, 1919)(p.29). They ate arrow-rash (Johnston, 1970). Sour-dock (*Rumex crispus*) (Gilmore, 1919)(p.37). They ate wild flax (*Linum lewisii*) (Gilmore, 1919)(p.64). They made sugar from the sap of soft maple trees (*Acer saccharinum*) and boxelder trees (*Acer negundo*) (Gilmore, 1919)(p.68).

Foods commonly collected by northern plains Indians were goosefoot, lamb's quarter, wild plums and grapes, berries (hackberries, buffaloberries, and chokecherries), and rose hips (Wood, 1998).

Cultivated foods. Maize (Indian corn), squash, beans, and sunflowers were the most common crops cultivated by Plains Indians. They cultivated bush beans and climbing beans (Gilmore, 1919)(p.63). They cultivated at least eight varieties of squash and/or pumpkins (they do not distinguish between the two, so it's difficult to say for sure) (Gilmore p.89). There is

archaeological evidence, including the occurrence of squash seeds (*Pepo maxima*) in mortuary bowls and pumpkin seeds in graves, which indicates they were used as food during ancient times (Gilmore p.91). Watermelons (*Citrullus citrullus*) are one of the crops that Indians have grown since ancient times. These watermelons were small, round and green, with a thin rind, red flesh, and small black seeds. There are numerous accounts of melons in various Indian tribes and the type of melon makes it clear that they are native to the continent and were not imported from Spain at the time of European contact (Gilmore p.93). Northern Plains Indians harvested wild rice and they depended substantially on wild rice for survival (Schlesier, 1994)(p.139). *Iva annua* (marsh elder) was domesticated by tribes in the Kansas City area (Schlesier, 1994)(p.203), but evidence suggests that cultivation of marsh elder decreased after 1300 A.D. (Drass, 2008).

"The vegetables they [the Iroqouis] cultivate most are Maize, or Turkey corn, French beans, gourds, and melons" (Gilmore p.95).

The foods most commonly cultivated on the northern plains were maize, common beans, sunflower, marsh elder, and cucurbits (Wood, 1998).

Intelligence and Sensing used for finding food

The Plains Indians used their intelligence for hunting. Not only did they use their brains to help them make weapons, like bows and arrows, they also developed ingenious ways of hunting the bison to kill or capture as many as possible. Many details are below; however, a general overview follows. One method Plains Indians used for hunting buffalo was to corral them by gradually funneling them into a smaller and smaller area-often by using fire or yelling hunters to scare the buffalo and keep driving them forward into a small corral, where it was easy for them to kill the trapped buffalo. Another way of hunting was to drive the buffalo off a cliff, killing or injuring many of them in the process, and then killing the remaining injured buffalo. They would also surround the buffalo with a wide circle of hunters and slowly close in on them, trapping them in the middle of the enclosed circle and killing them once they were trapped.

When it came to gathering food, the primary use of intelligence was simply remembering where large quantities of a particular food grew, then, they would migrate past those areas, gathering the food as they went. They also robbed mouse and vole nests to gather some food. They did use their visual skills to identify when the best time was to gather specific foods, for example, they gathered bitterroot when the flower buds appeared above the soil.

They used their skills of observation to help inform their agricultural techniques. For instance, the Omaha planted corn when the wild plums began blooming (Gilmore, 1919)(pp.49-50). They used the blooming of goldenrod (*Solidago sp.*) as an indication that it was time to return home from the hunt to harvest the corn: "the sight of the goldenrod as it began to bloom caused them to say, 'Now our corn is beginning to ripen at home'" (Gilmore, 1919)(p.109).

Locomotion

Horses. The Spanish reintroduced the horse to North America in the late 1500s but were widespread only after the Pueblo Revolt of 1680. After the revolt, the Spanish abandoned New Mexico and the Pueblo Indians started trading horses with Plains Indians nomads. Once trade started, the use of horses among Plains Indians spread quickly, reaching the Missouri River around the 1730s and the Canadian Prairies around the 1770s. While Indians throughout the Plains used horses, they were less commonly used among the Northern Plains groups because the harsh weather in the north decreased the number of offspring born to horses and made them difficult to feed during the winter, resulting in a lot of horse deaths during the winter. In contrast, Southern Plains Indians had four to six horses per person. Horses revolutionized the Plains Indian way of life and many historians divide Plains Indian history into two periods, prior to and after the arrival of the horse. They allowed the Indians to trade, hunt, and wage ware more effectively. The combination of horses and the arrival of guns in the mid-1700s changed their hunting behaviors because mounted groups of Indians were able to keep pace with buffalo herds. This allowed them to follow the herds around the plains. It should be noted that, until guns became more accurate, they continued using bows and arrows to hunt. Overall, horses allowed the Plains Indians to be more nomadic, staying in villages during the spring and fall, but hunting during the summer (Prine Pauls, 2018). They also allowed them to build bigger tipis (because they could pull larger tipis behind horses than behind dogs), to own more items, and to transport the sick and the old who previously would have been abandoned. Horses were eight times as efficient as dogs and could carry a travois load four times heavier than a dog could carry and could travel twice as far in one day. Horse ownership also changed the political structure of Plains Indian society, promoting a hierarchical society where the ownership of more horses put an Indian in a higher social class (*Encyclopedia of the Great Plains Indians*, 2007)(pp.83-84, p.206).

Dogs. Prior to the adoption of the horse, dogs were one of the Plains Indians means of transporting goods. Dogs dragged the Indians' supplies, like tipis, on a platform on top of a travois. Dogs could only haul about sixty pounds, so humans did most of the carrying themselves (*Encyclopedia of the Great Plains Indians*, 2007)(p.206). Also, dogs couldn't travel as far as horses, so the Plains people did not travel as much when they used dogs (Prine Pauls, 2018). After the adoption of the horse, the Indians of the Northern Plains often relied on dogs for transportation because it was not feasible to maintain a large, healthy herd of horses (*Encyclopedia of the Great Plains Indians*, 2007)(p.84). Southern Plains Indians used dogs after the introduction of the horse to carry small items, like household utensils and moccasins (*Encyclopedia of the Great Plains Indians*, 2007)(p.206).

Pedestrian. In the Northern Plains, Indians often hunted on foot for the same reason they used dogs for transportation, because they couldn't maintain herds of horses (*Encyclopedia of the Great Plains Indians*, 2007)(p.84).

Canoes and boats. Rivers in the plains were often dry for such a large proportion of the year that water transportation was rare. However, a few Plains tribes, like the Assiniboines, Crees, and Blackfoot, used canoes. Along the Missouri River, tribes used bull-boats to transport goods (*Encyclopedia of the Great Plains Indians*, 2007)(p.206). Bull-boats (a.k.a. coracles), were circular, basin-shaped vessels made from a bent willow frame covered in fresh bison hides. Once the hides dried, the boat was drum-tight. Bull-boats also had a driftwood drag for stability (Carlson, 1998)(p.58). The adoption of the horse resulted in Plains Indians abandoning the use of canoes; however, some groups, like the Santees, did not abandon canoes until the 19th century (*Encyclopedia of the Great Plains Indians*, 2007)(p.206)(Carlson, 1998)(p.58).

Travois. The travois is unique to the Plains. It is a load-bearing A-shaped made of two wooden poles (aspen or cottonwood) tied together at one end with buffalo sinew with crossbars lashed between the poles near the splayed end of the poles so that it is A-shaped. The travois is fastened onto a dog or horse using a leather harness and the apex of the A is wrapped in buffalo skin to prevent friction on the dog's shoulders. The splayed ends drag over the ground and produce minimal friction over the grass, appearing to float. Women built the travois and managed the dogs. The weather affected travois use, because dogs overheated easily on warm days, decreasing the amount of time they could work. Travois carried all types of goods and, when horse pulled travois, they could carry people, though it was somewhat uncomfortable because the people's legs hung over the poles (*Encyclopedia of the Great Plains Indians*, 2007)(pp.206-207).

Territory

Housing. The Plains Indians lived in three different types of houses, each of which were easy to travel with or easy to build, supporting their nomadic way of life. The most common structure they lived in was the tipi, and they most often lived in tipis when they were hunting because they had to move so often. Tipis were tent-like, conical structures made with poles covered in animal hides. Three-to-four main poles leaning in towards one another were tied together, make the structural base of the tipi, with an additional 10-15 poles providing additional support for the animal hides. One tipi required about 14 to 20 buffalo hides to cover the entire thing! Women owned the tipis and it was their responsibility to sew together the hide coverings with sinew and build them (it took two women to put up a tipi and the men never helped). The buffalo skins were often painted with pictures of the eldest male resident's war exploits or visions. The tipis were quite large, about 10 feet in diameter prior to the horse, and about 15 feet in diameter after the adoption of horses into Plains Indian culture. The 15ft diameter tipis had an interior of 175 square feet and typically housed a two- or three-generation family. A flap of the tent covering was used as a door and people scratched or rubbed on the tent wall instead of knocking. Tipis were adaptable to all types of weather. For example, they could be heated by a fire in cold weather because there was a smoke hole in the top of the tipi. During storms, the smoke hole was closed to keep out the bad weather. During warm weather, the sides of the tipi could be rolled up to provide additional ventilation. It only took an Indian village about one hour to pack up their tipis, which made it easy for them to quickly follow herds of buffalo. They carried both the buffalo hides and the poles with them when they moved, in part because of the small amount of trees in the Great Plains. (Prine Pauls, 2018; University of Chicago, 2007).

The wickiup (aka wigwam) was a type of housing typically used by the Plains Indians of the Northeast (like the Iroquois). Wickiups were made of tall saplings that were driven into the ground and then bent over and tied together at the top. Overlapping mats of woven rushes or bark were tied to the saplings to cover them. Wickiups were similar in size to tipis and were 15-20 feet in diameter and housed a similar number of people at that of tipis. Wickiups were also portable and easy to construct (Editors of Encyclopaedia Britannica, 2011) .

Most Plains Indians village tribes used earth lodges as their primary housing structure. Earth lodges were bigger than tipis, averaging 40-60 feet in diameter, with a 1200-2825 square foot interior. Earth lodges housed three-generation families. Earth lodges had dome-shaped roofs and walls made of earth. People entered the lodges through a covered passageway. The Indians used a rattle made from deer hooves as the door knocker. Similar to tipis, earth lodges belonged to the women of the household. Earth lodges were often used in the wintertime to stay warm, since the Plains Indians didn't travel during the winter. They were also used as defensive bunkers (Prine Pauls, 2018; University of Chicago, 2007).

After the introduction of the horse into mainstream Plains Indian society in the mid-1700s, they became more nomadic. They lived in their villages in the spring and fall, where they planted and then harvested crops. During the summer, they travelled with horses, hunting buffalo herds across the plains. In the winter, they lived in hamlets with a few homes in the wooded bottomlands, because they provided shelter from winter storms (Prine Pauls, 2018).

War. The Plains Indians have a long history of intertribal warfare. Excavations at Crow Creek from around 1325 indicate that the entire town of 486 people were slaughtered, with data indicating that the people were severely malnourished, suggesting that they were killed because of competition for food due to overpopulation and the poor climate. Violence was common among farming tribes from the 1500s through the late 1800s. Warfare was common among nomadic tribes by the 1700s because of conflict over hunting territories. After European contact, war in the Plains intensified because eastern tribes started migrating west and because of competition for access to Americans and Europeans for trade (*Encyclopedia of the Great Plains Indians*, 2007)(p.103). After the adoption of the horse into Plains Indian culture, horses became a central factor in intertribal conflicts. The adoption of the horse also allowed men more time to conduct warfare (Carlson, 1998)(pp.38-39). Additionally, the greater mobility allowed by horses resulted in the Plains Indians covering more territory, leading to more intertribal contact. Many tribes wanted to acquire new hunting ranges, which often led to warfare (Carlson, 1998)(p.43). Weapons included bows, arrows, lances, knives, and war clubs. They also used shields, which were circular, light-weight items made from bison bull shoulder hides and fixed with a strap attached to the arm. Warriors decorated their shields and shaman often blessed them (Carlson, 1998)(p.61). (Luke-There is A LOT of information on war. Please let me know if you want more information.)

Capture

Transitions between hunting and gathering/farming. The Plains Indians transitioned back and forth between relying predominantly on hunting versus gathering/farming a few times throughout their history. Prior to 1000 AD, hunting was their primary economic activity; however, around 1000 AD, the climate became wetter and they focused increasingly on farming, putting hunting on the back-burner. By the 1200s, the majority of plains Indians lived in the

eastern river valleys, predominantly farming and only hunting sporadically. This changed with the introduction of the horse in the 1600s and 1700s. As mentioned elsewhere, the introduction of the horse into Plains Indian culture allowed them to hunt large animals, especially bison, more effectively and they could follow migrating herds closely, over a wider range of territory. Horses also allowed them to carry more meat and hides. Thus, the Plains Indians shifted back to focusing on hunting over farming (*Encyclopedia of the Great Plains Indians*, 2007)(p.88).

Hunting methods and techniques

Men were responsible for hunting and did their major tribal hunts during the summer and fall, though individuals could hunt at any time (Carlson, 1998)(p.56). Hunting weapons include bows and arrows, lances, and knives. Lances were made from a pole tipped with a flint or metal point. Hunters made their bows from wood or pronghorns. The preferred wood was Osage orange wood, also known as bois d'arc; however, if this was unavailable, they would use just about any other type of wood. After cutting the wood or bone to the correct length, and some men strengthened their bows. Those who strengthened their bows backed and wound their bow with sinew from the bison's backbone. Bow strings were made from a variety of materials, including bison sinew, rawhide strips, bear intestines, squirrel hide, or twisted vegetable fibers. Arrows were difficult to make, and it was imperative to make them well so that they would aim straight. Men used a variety of woods to make arrows, including gooseberry, currant, willow, serviceberry, juneberry, etc. The preferred wood depended on the tribe. Men cut the shafts to their desired length and shape and tied them in a bunch to season near a fire for about ten days. After the shafts dried, men used a combination of their teeth, fire, grease, and a special arrow straightener (made out of bone or horn with a hole slightly larger than the shaft that the arrow based back and forth through) to make the arrow round. After straightening the shaft they painted and polished it and then attached feathers (preferably owl, turkey, or buzzard) with glue. Stone points were originally used; however, after contact, it was much more common to use metal. According to Carlson, after the 1850s, most men couldn't remember using stone points. Hunters typically decorated their weapons (Carlson, 1998)(pp.61-62). Although bows and arrows were commonly used for hunting, they had only been used for about 1,000 years at the time of European contact. Spears were the first tools used for hunting by Plains Indians. They also used the atlatl, which was a sling-like device that helped them throw the spear, giving it more power and distance (Park, Hongu, & Daily III, 2016).

Pre-horse. Prior to the introduction of the horse, the Plains people hunted animals, like deer, elk, pronghorn antelopes, grizzly bears, and bison. They hunted animals by camouflaging themselves in animal skins and stalking the animals, ambushing animals at watering holes, driving herds into manmade corrals, or stampeding bison over a cliff and then slaughtering the wounded bison with spears, darts, or stones. Around two thousand years ago they learned how to use bows and arrows and began killing animals from a distance (*Encyclopedia of the Great Plains Indians*, 2007)(p.88). Since it was difficult for the Plains Indians to follow large herds on foot, especially after they had killed one bison and the rest of the herd moved away, they didn't follow the herds. Rather, they chose to settle in an area where the bison typically fed at certain times of the year. They camped in thickets with the hope that the bison would come close enough for them to

ambush them. Then, they were typically able to kill one or two bison a day (Haines, 1976)(pp.13-14).

The foot surround was a common hunting technique. When using the foot surround, a long line of Indians would slowly encircle a herd of animals and then gradually shrink the circle, moving in to kill the animals (*Encyclopedia of the Great Plains Indians*, 2007)(p.89). Some groups used grass firing to help augment the effectiveness of the foot surround (Carlson, 1998)(p.40).

Another method similar to the foot surround was *pis kin,* meaning "deep blood kettle' in the Blackfeet language. This method is also known as impounding. When impounding, the hunters essentially drove the herd into the open end of a man-made funnel, scaring the bison to run forward into the narrowing tip of the funnel, which was an enclosure of logs and brush. Once the bison arrived at the tip of the funnel, they would sometimes butcher the entire herd, kill from 300-600 animals (Carlson, 1998)(pp.40-41).

The Indians stampeded bison over the edge of cliff using methods similar to those used in impounding. Animals at the edge were pushed over by the animals behind them. This killed or wounded the animals, with the hunters killing the wounded animals. (Post-horse contact, the Indians drove bison over the edge while mounted on horses) (Carlson, 1998)(p.41).

During the winter, bison became exhausted or mired down in snow drifts and men could approach them, killing the bison with arrows or a lance. During warm weather, they sometimes killed bison while they swam in rivers. Younger men would swim along the bison's side or crawl on top the swimming bison and cut its throat. This was very dangerous, so was less often used for acquiring meat than for sport (Carlson, 1998)(pp.41-42).

Post-horse. After the introduction of the horse, the Plains people developed specialized hunting techniques based on seasonal and geographic variations of the regions in which they lived. During the winter-time, hunters drove bison into snowdrifts or snow-filled gulches. In the summer, they drove them into corrals, swamps, or rivers. They also burned sections of the grasslands to increase the predictability of bison migrations and groupings. The most popular method of hunting, which is often depicted in paintings of Indians hunting, was the mounted chase. During the mounted chase, hunters galloped after the bison while thrusting lances or shooting arrows into the bison's sides. They used the short bow in preference to guns because guns were difficult to load and handle on horseback and both gunpowder and balls were expensive. As such, they saved guns for warfare (*Encyclopedia of the Great Plains Indians*, 2007)(p.88).

During the winter and spring, Plains Indians hunted in groups of a few people. During the summer and fall, they hunted in groups of hundreds of people. Mass hunts happened in several stages, and each stage was consecrated by a religious ritual. The first stage was to 'call the bison' and helped them find the herd. Once they found the herd, distinguished warriors policed the camp to keep anyone from starting the hunt early, because that would cause the herd to stampede and decrease their success. The chief orchestrated the hunt and ordered the entire camp to move out in an orderly fashion, starting with the scouts and followed by medicine men, priests, leaders, and, finally, old men, women, and children. Young men rode on the sides of the columns to

provide protection and stay prepared to charge once they came in sight of the bison. The actual hunt lasted around 30 minutes. After finishing the chase, hunters and their families moved in to butcher the animals. Hunters designed their own arrows and lances and their distinct designs helped them recognize which kills were theirs (*Encyclopedia of the Great Plains Indians*, 2007)(p.88).

The Plains Indians continued hunting deer, elk, bears, porcupines, and other animals after the introduction of the horse; however, by the late 1700s, most Plains Indians depended on the buffalo for survival. However, over-reliance on the buffalo for survival quickly decreased buffalo populations and, by the mid-1800s, the buffalo population was so small that the Plains Indian hunting culture ended, with the Plains Indians abandoning the hunt entirely by the 1890s (*Encyclopedia of the Great Plains Indians*, 2007)(p.89).

In the Northern Plains where horses were less common, the Plains Indians continued hunting on foot and using the technique of the foot surround (*Encyclopedia of the Great Plains Indians*, 2007)(p.89).

Fishing. Fishing was another major source of food for Indians, as many villages were near rivers, allowing them to hunt both fish and water fowl. The most common fishing method was using a spear to stab the fish, which was used throughout the year, even when in the winter, when they would cut a hole in the ice and spear the fish through the hole. Three-pronged spears were used for smaller fish. Plains Indians also made nets from vines and they made traps and fish hooks from bone. Nets were placed across channels or streams where the fish were most likely to swim and were anchored using poles. The top of the nets extended above the water like fences and patterns were designed to make sure the fish were impounded. Similar to impounding bison, the Blackfoot made basket traps that were shaped like a funnel, the large opening upstream and the closure of the funnel downstream. The fish would swim into the funnel and get stuck in the bottom of the funnel by the power of the current. Another fishing method, known today as 'noodlin', a man wrapped his hand with a cloth and put it in a catfish hole underwater. Once the catfish tried to swallow the man's hand, the fisherman pulled the catfish out of the stream. Another method was to stunning the fish by putting round black walnut hulls into pools. This made the fish float the surface, then they were easy to capture (Park et al., 2016).

Insects. Some Plains Tribes ate insects, depending on where they lived and often during lean times. One way of capturing grasshoppers was digging a ten to twelve foot wide hole about four or five feet deep. Then, the men would make a larger circle around the hole. They worked together beating the ground and scaring the insects, making them jump forward, chasing them forward until they jumped into the hole. A similar method was to dig a hole in a meadow and set fire to the grass around the pit, driving the insects into the pit. The fire burned the insect wings so that they couldn't fly away. This method was used for grasshoppers and locusts. Worms were gathered by pulling them off of plants during the rainy season (Skinner, 1910). The pupae of read flies, called kutsavi, were gathered when they washed up on the beach by waves (http://www.hollowtop.com/finl_html/amerindians.htm).

Plant gathering and farming methods

Gathering Foods. Prior to developing horticultural techniques, the Plains Indians gathered foods, like bulbs, roots, shoots, berries, nuts, and fruits (Haines, 1976)(p.15).

Prairie turnip. Prairie turnips were gathered in June and July (Gilmore, 1919)(p.57) and were so important to the Omaha that they changed the route of the summer buffalo hunt based on the locations where women could find the turnip (*Encyclopedia of the Great Plains Indians*, 2007)(p.156). Most tribes used fire-hardened digging sticks made of cherry or birch wood to gather the prairie turnips, though some, like the Pawnee, may have used bison scapula hoes (Kaye & Moodie, 1978; Reid, 1977).

Camas. In the Northern plains, families often returned to the same patches to gather turnips, resulting in camas gathering having territorial implications for families (Schlesier, 1994)(p.58). Camas roots were gathered in July, when the followers began to fade (Johnston, 1970).

Fruits and Berries. Saskatoon berries were so important that villages were moved to be close to the berries during berry-picking season. Berries were gathered in rawhide bags and then transferred into larger storage bags. Chokecherries were also highly valued and people traveled miles to gather cherries (Gilmore, 1919)(p.51).

Fungi. Plains Indians gathered oyster mushrooms in groves of box elders near the places they tapped trees for sap. Corn smut, which grows on corn (not surprising…) was gathered as soon as the spores appeared (Gilmore, 1919)(p.16).

Other gathered foods. Women gathered ground beans by robbing rat, mouse, or vole nests. When gathering them from nests, they replaced the stolen beans with other foods, often corn: "They said it would be wicked to steal from the animals, but they thought that a fair exchange was not robbery" (Gilmore, 1919)(p.61).

Western spring beauty corms were dug in the spring. Bitterroot was gathered when the flower buds appeared above the soil. Canadian milk vetch roots were gathered in the fall or spring. They harvested yellow lotus tubers by wading into ponds and searching for them with their toes in the mud, removing the mud with their feet, and using a hooked stick to pull them out. These tubers look like a small banana (Gilmore, 1919)(p.39).

Cultivating Foods. Archeological evidence indicates that the Plains Indians established horticultural practices as early as A.D. 800 and that horticulture was practiced even in the northern areas of the Plains, like in present-day North Dakota. Researchers found a packet of squash seeds (*Cucurbita pepo, ovifera* variety) in a leather pouch near the Sheyenne River in southeastern North Dakota, as well as maize kernels and cob fragments (Schlesier, 1994)(p.81)(Schneider, 2002). Although horticulture was practiced early in Plains Indians' history, it likely was not a major contributor to diet in prehistoric groups, but contributed their survival, in combination in gathering wild plants and hunting. Horticulture likely helped prehistoric Plains Indians survive by providing subsistence to help balance the fluctuating availability of wild plants and animal-based foods (Schneider, 2002).

Garden plots were typically rectangular areas containing one to five acres of land and separated by uncultivated areas about four feet wide (Carlson, 1998)(p.55). Women owned their plots and

cultivated the food, including corn, squash, sunflowers, beans, and other crops (*Encyclopedia of the Great Plains Indians*, 2007)(p.156). In addition to owning the garden plots, women owned and were responsible for distributing the food produced in their plots. Women used hoes made out of bison scapula (Schneider, 2002). Horticultural practices were poorly developed and the Plains Indians didn't know about rotating or fertilizing crops; however, they would leave fields fallow and/or burn trees and brush on them. The burning destroyed the seeds of weeds. The ash from burning was a somewhat effective fertilizer. Before the introduction of the horse, and the subsequent long periods of time spent away from the village, women and children spent a lot of time watching over the crops to prevent damage due to rabbits, birds, deer, stray horses, and other animals (Carlson, 1998)(p.55). Corns, beans, and squash are often referred to as the *three sisters* of Native American agriculture (Park et al., 2016).

Corn. Corn was the staple vegetable in Plains Indians' diets, so most fields were used to grow corn. Each tribe planted a wide variety of corn. For example, the Hidatsa planted at least nine corn varieties. Women made sunshades for young corn (Carlson, 1998)(p.55). When corn was harvested in September, the best ears were put aside to provide seed corn for the next year's crop. The seed corn was left on the cob (Haines, 1976)(p.21). The Plains Indians intentionally planted different varieties of corn far away from one another to maintain the purity of individual varieties. They also gathered corn silks (Gilmore, 1919)(pp.23-24). The Omaha planted corn when the wild plums began blooming (Gilmore, 1919)(pp.49-50). They used the blooming of goldenrod (*Solidago sp.*) as an indication that it was time to return home from the hunt to harvest the corn: "the sight of the goldenrod as it began to bloom caused them to say, 'Now our corn is beginning to ripen at home'" (Gilmore, 1919)(p.109).

Beans. Beans were typically grown in hills between rows of corn; however, sometimes beans were planted in their own crops. Similar to corn, they planted a large variety of beans, with the Hidatsa planting five bean varieties (Carlson, 1998)(p.55). Similar to corn, they planted beans when wild plums bloomed (Gilmore, 1919)(pp.49-50). According to Gilmore, European contact led to losses in the variety of beans grown; however, the Omaha Indians could remember fifteen different varieties of beans that they grew prior to European contact (Gilmore, 1919)(p.63).

Squash and Pumpkins. Squash and pumpkins were planted in their own plots because they spread out while growing and didn't thrive when sharing a plot with other plants (Carlson, 1998)(p.55). Squash and pumpkins were planted at the same time as corn, when the wild plum blossomed (Gilmore, 1919)(p.90).

Other cultivated plants. The Plains Indians also cultivated potatoes, tomatoes and peppers in smaller quantities (Park et al., 2016). Sunflowers were cultivated but not for food. Rather, they used the oil from sunflower seeds in their hair.

Food Storage and Preservation

General. Drying was a common method of food preservation.

Animal-based foods. Women made jerky by cutting meat across the grain into thin strips and then drying it on racks in the sun.

Cold Storage. Plains Indians in the Snake River Plain (in southeastern Idaho) used lava tube caves to store bison meat year-round. These caves have unique features that allow them to maintain a temperature of 34 degrees or lower throughout the year. The Plains Indians practiced cold storage of bison for the past 8000 years. They used tines made of elk antlers and stone hammers to extract frozen bison meat (Henrikson, 2003).

Pemmican. Pemmican was a common way to preserve meat. Women made pemmican by pounding jerky with a maul and mixing the pounded meat with bone marrow, melted fat, suet, and a dry paste made from crushed berries, plums, or cherries. Walnuts, pecans, or other nuts were often added for flavor. Once everything was mixed together, it was stored in a skin bag, in paunches, or in large intestines. Melted tallow was often used to make the container airtight, and the pemmican would keep for years. Women typically saved pemmican for winter use; however, sometimes warriors took pemmican with them on raids and children ate it as a snack (Carlson, 1998)(pp.56-57).

Fish. Fish were smoked for anywhere between several hours to two to three days. Smoking happened in either smoke sheds or tipis, where the raw fish were arranged on racks or hanging on lines above the smoke source inside the shed or tipis. Salmon were so large that they were typically cut into strips before they were smoked and dried.

Insects. Insects, like grasshoppers, were often crushed and made into a paste that they dried in the sun or near the fire. This dried paste could then be stored for later use. Another preservation method was to dried whole grasshoppers and locusts and then store them for winter use. Worm skins were braided together and dried for a couple of days in the sun (Skinner, 1910). Kutsabi, the pupae of read flies, were dried in the son and could be stored for later consumption.

Plants. Women sliced squash and hung it on long poles to dry. Corn was either left on the cob to dry, or was shelled, dried on animal skins, and then stored in skin bags (Carlson, 1998)(p.56). Some corn was harvested when green, while the remainder was allowed to ripen. The ripened corn was shucked, dried, and shelled, and then put into storage caches for the winter (Haines, 1976)(p.21). The Plains Indians built caches to store foods they harvested during the fall, like nuts, seeds, bulbs, and roots. They built caches near caves or put their caches close to streams, along which they settled for the winter (Haines, 1976)(p.15).

Prairie turnips were peeled and then dried for winter. The stems were often braided together and dried on meat racks prior to storage (Reid, 1977). If the roots were very large, they were sliced and then air-dried prior to storage. Sometimes they were dried in the smoke of fires (Kaye & Moodie, 1978). They were stored in skin bags. The dried roots can last for years without changing in quality but they need rehydrated by simmering overnight before cutting and cooking them. Dried roots were also pulverized into a powder using a berry-pounding stone and then used as thickeners for soup or to provide flour making breads (Reid, 1977; Stahnke et al., 2008). The prairie turnip was an importance subsistence food during the winter time for most Plains Indians (Reid, 1977).

Camas root was prepared by digging a hole in the ground about 12-14 inches deep and 12-14 inches wide. They covered the bottom of the hole with wood, which they burned until they had a bed of embers. They spread stones over the embers and then a layer of earth over the stones. The roots were placed on top of the earth layer and then covered with another layer of earth. Finally, they topped this off with a lot of wood, enough to maintain a fire for anywhere between 30 and 70 hours. After the camas root was cooked, it had a consistency similar to a date. This could be preserved for a very long time or made into loaves (Johnston, 1970). Yellow lotus tubers were peeled, cut into one inch long pieces, and then dried for winter food use (Gilmore, 1919)(p39).

Bitterroot was often peeled and then dried. Many berries, such as Saskatoon berries, thorny buffalo berries, bilberries, and hawthorn fruit were dried in the sun and then stored for later use (Johnston, 1970). Wild plums were dried for winter use and, depending on the tribe, the pits may or may not be removed (Gilmore, 1919)(p.49). Sand cherries, chokecherries, wild grapes, and prickly pear fruit were also dried and put into winter storage (Gilmore, 1919)(p.51,p.69,p.72).

Food Refinement: Preparation and Cooking

Women boiled, roasted, broiled, or baked food. Women boiled food in skin containers or in earthenware pots. Another method for boiling food was digging a hole in the ground, lining the whole with a skin container, filling it with water, and then boiling it by dropping in red-hot rocks. Food stored in skin containers was then submerged in the boiling water. Foods were roasted on a spit over the fire, while broiling happened on the coals. Women baked foods underground.

Tools for preparing and eating food. Plains Indians made tools from stones, horn, bones, and green wood. They made spoons, ladles, and dishes from bison or sheep horns. They put handles on most of their tools. For example, they wrapped green wood and rawhide around a grooved stone and dipped the tool into glue. Once the glue dried and the hide shrunk, the tool was ready for use (Carlson, 1998)(p.60).

Animals

Immediately after the hunt, Indian families gathered around their hunter's kills and drank the warm blood. Then they sorted and cut the carcasses. They would often eat raw pieces of meat while processing the animals. One raw meat preparation method was to eat a combination of raw brains and bone marrow that were stirred together in a section of ribs used as a bowl (Carlson, 1998)(p.56).

Bison. As soon as the chase was over, the entire family moved in to find their hunter's kills. Then, they quickly butchered the bison, slicing up meat, tallow, and hides (*Encyclopedia of the Great Plains Indians*, 2007)(p.88). When rendering buffalo fat, the Omaha cooked the fat with the inner bark of the red elm tree because they liked the flavor and believed it helped preserve the quality of the tallow, keeping it from going rancid (Gilmore, 1919)(pp.34-35).

When butchering bison, the Plains Indians first rolled the bison onto the belly and cut the skin down the back, pulling it down on both sides of the carcass to form a mat on which to place the meat. They cut out the layer of meat directly under the skin of the back and then cut the bison's forelegs and shoulder blades off. This allowed them to access the hump meat, rib cage, and body cavity. It is most likely that they immediately ate some of the internal organs raw. They also removed the tongues and ate them immediately. They used a hammer made of a bison leg bone with the hoof still attached to break the ribs off near the spine. Then they severed the spine behind the ribcage and removed the hindquarters. They cut the pelvis away from the pelvis and discarded the pelvis girdle. The neck and skull were cut off together and cut the neck meat off. They cut the neck meat into strips, dried it, and then pounded it to use in pemmican. It is unlikely that Paleo-Indians broke open the skull to take out the brain, though more recent Plains Indians did remove the brain. Tools they used included hammer stones and knives. They also had stone scrapers for processing the bison's skin on site. 100 pounds of fresh meat provided 20 pounds of dried meat. Apparently, the Paleo-Indian hunters killed enough bison to have 56,640 pounds of meat, 4,000 pounds of internal organs, and 5,400 pounds of fat (Wheat, 1967).

Apparently, a man could consume 10-20 pounds of fresh bison meat in a day. Fresh buffalo meat lasted for about a month (Wheat, 1967). Almost all people consumed organ meat, including raw kidneys, tallow around the kidney, loin tallow, and the paunch. Fresh liver sprinkled with bile from the gall bladder was considered a delicacy, particularly for children. The bison's heart was often eaten raw and was considered a symbol of the animal's strength and bravery. Curdled milk from the stomach of a bison calf was also consumed (Carlson, 1998)(p.56).

"Bone grease, or marrow fat, was made by splitting the bison bones and pounding them with a stone hammer. The bones were boiled and when the marrow rose to the top it would be skimmed off and eaten with dried meat. Bison meat was kept for many years by cutting lean pieces of flesh into strips and smoking them [4, 33]. Sioux enjoyed roasted bison hump soup with hooves and tails and pemmican. They considered boiled bison brains, gristle about the nostrils and tongue delicacies [36]. The choice parts of the bison were the tongue, shoulder, fat from the teats and the heart. The liver was usually eaten raw and men drank warm blood so they would be fine with seeing it in battle. On occasion, the older people would sometimes cut out the teats of a milking bison and drink the milk" (http://traditionalanimalfoods.org/mammals/hoofed/page.aspx?id=6136).

Pemmican Recipe: Modern Day version-Notes on likely differences in Paleoindian food preparation

PEMMICAN (By Patricia Rowland)

- Dried meat (buffalo, game or beef) (just buffalo in Paleoindian version)
- Dried chokecherries (juneberries can be used as well) (use about the same amount as the dried meat)
- Nuts sometimes added as well
- Sugar to taste (not in Paleoindian version)

- Lard (to hold together) Do not use shortening or butter. (Buffalo tallow in Paleoindian version)

Pound meat very thin and dry in the oven. Grind the dried meat in a food processor. (Originally pounded and mixed by hand.) Add the chokecherries and blend together. The consistency should be dry and loose with fruit broken up. Add melted lard slowly while mixing. Two tablespoons of fat are used for each 4-5 ounces of meat plus 1/3 cup of fruit. Fat changes the consistency and makes it appear semi-moist instead of dry and improves the flavor and texture. Store in paper bags. (Paleoindians would have stored this in skin bags or large intestines.) ("Native American Recipes," 2018)

Osage Strip Meat Soup

By Andrea Hunter, Osage Tribal Historic Preservation Officer

Photo by D. Mihesuah

Ingredients:

3 or 4 pounds of buffalo meat, preferably from rump.
Take the buffalo meat and following the grain, cut into strips about as thick as one's thumb and about 1 1/2 to 2 inches long. Wash meat. Put in kettle and cover with cold water, no more than 1 inch over the meat. Take a ladle and mash the meat. Put on fire to boil. Boil about 45 minutes to 1 hour with no lid. Serves 12 or so (Hunter, 2018).

Fish. Fish were typically cooked by skewering them over a fire. Less commonly, they fried fish in the pan. It was also quite common to add fish to soups and stews and served with corn mush (Park et al., 2016). (Post-contact: Another way to cook fish was cleaning them, salting the fillets, and letting them stand overnight. Then, they strung the fish on a stick and roasted over a fire.)

Insects. Grasshoppers were eaten in soup or boiled. Another way they prepared them was called *en appalas*. This method involved stringing large grasshoppers on rods and putting the rods near the fire, where they roasted. Dried grasshoppers and locusts were eaten dry and uncooked or slightly roasted. Pulverized grasshoppers were also mixed with service berries and/or wild currants and then dried in the sun into a type of dessert similar to a fruitcake. In the Southwest,

the Pima Indians pulled the heads off of worms and removed their intestines, then they boiled them for consumption. Dried worm skins were also eaten without any more preparation (Skinner, 1910). Dried kutsavi were mixed with berries, acorns, and other plant foods into a bread-like food called cuchaba. These worms were also eaten by frying them in their own fat.

Plants

Corn. Some corn was picked in August, when it was still green. This corn was roasted or boiled in the husk. The corn kernels were then removed from the cob and dried in the sun before storing them for the winter. The remaining corn ripened and was harvested in September. This corn was saved for winter time (Haines, 1976)(p.21). Some ripened corn was also pounded into cornmeal, parched, or hulled with lye gathered from ashes to make hominy. Corn silks were dried and ground with parched corn to make it sweet (Gilmore, 1919)(p.24). They used processing methods, like soaking corn in lye made from ashes, which increased the bioavailability of niacin and protein in the corn and, due to increased niacin bioavailability, also increased bioavailability of calcium and phosphorus (Mailer & Hale, 2015).

Prairie turnips. Prairie turnips were often peeled and used fresh. The fresh roots were either roasted, eaten raw, or cooked in soups and stews (Stahnke et al., 2008). The Cree Indians dug pits in their tipis and baked the turnips under the coals (Reid, 1977).They apparently have a bean-like taste (Gilmore, 1919)(p.57).

Other tubers. Many tubers, like the Indian potato and Jerusalem artichoke were boiled or roasted (Gilmore, 1919)(p.59, p.105). Yellow-lotus tubers were peeled and cut up to cook with meat or hominy. Their seeds were cracked and used with meat for making soup (Gilmore, 1919)(p.39). The spring stalks of cow parsnips were peeled and roasted on hot coals. Varieties of prairie parsley were eaten raw or roasted (Johnston, 1970). They ate water-plantains raw, boiled, or roasted in ashes. Bulrush roots were eaten raw and cooked (Johnston, 1970).

Camas. Camas root was cooked by roasting or boiling and it was often. Camas root tastes has been compared to the taste of roasted chestnuts or a baked pear. The sweet flavor of cooked camas root meant that it was often used as a sweetener to enhance the flavor of other foods (Turner & Kuhnlein, 1983). Bistort roots were used in soups and stews. The corms of western spring beauty were eaten fresh or roasted. Bitterroot was steamed if it was still fresh or was boiled if it had been dried. It had a bitter taste (obviously…). Silverweed roots were eaten boiled or roasted. Canadian milk vetch roots and the pods of ground plums (*Astragalus crassicarpus*) were eaten raw or boiled. Squawroot was eaten raw or boiled. Arrow-leaved balsamroots are super starchy, because of this, the Plains Indians crushed the roots, removed the fibrous material, and used the remaining plant material as food. The leaves of arrow-leaved balsamroot plants were used in camas-cooking. White thistle roots were eaten raw or cooked with meat (Johnston, 1970). Arrow-leaf tubers were boiled or roasted (Gilmore, 1919)(p.20). Red lily tastes like licorice (Gilmore, 1919)(p.59).

Fruits and Berries. Women used a grooved-stone hammer to pound chokecherries, hackberries, or other berries on a flat stone, which were then added to pemmican. Berries and fruits were typically eaten raw (Gilmore, 1919; Park et al., 2016)(p.35). Wild plums were highly valued and

were eaten fresh or cooked as a sauce (Gilmore, 1919)(p.49). Creeping mahonia berries were eaten fresh and tasted strongly acidic. Gooseberries were eaten fresh because they withered quickly after being picked. Saskatoon berries were 'probably the most important vegetable food of the Blackfoot' and were used in stews, soups, or with meats. They made a soup from buffalo fat and the berries mixed with buffalo blood, which was a favorite dessert at Blackfoot feasts. The berries are as sweet as currants. Chokecherries were also used in soups or stews, eaten fresh, or mixed with pemmican. When mixed with pemmican, the cherry pits were included. Bilberries were eaten fresh (Johnston, 1970).

Hawthorn fruit was eaten fresh. Wild strawberries were eaten raw because they were too juicy for preservation. Wild red raspberries were eaten fresh and the leaves were used in tea. Thorny buffalo berries were eaten fresh. The bearberry was either eaten raw or preserved (Johnston, 1970). Sand cherries and ground cherries were made into a sauce and chokecherries were eaten fresh (Gilmore, 1919)(pp.50-51). Buffalo berries and elderberries were eaten fresh (Gilmore, 1919)(p.74). Wild grapes were eaten fresh and some Indians tapped grapevines in the spring and drank the sap, which tasted like grape juice (Gilmore, 1919)(p.69). The bristles were removed from prickly pear fruit, then they were eaten fresh and raw or were stewed. During times of famine, Indians ate the stems of prickly pear after removing the spines and roasting them (Gilmore, 1919)(p.72).

DRIED BERRIES (Traditional Northern Cheyenne berries such as chokecherries, buffalo berries or wild blueberries)

1. After picking the berries, put them, including the seeds, in a blender or food processor and blend/process into a pulp. (Traditionally, the berries were pounded, including the seeds, to a pulp with a formed rock).
2. Form the pulp into patties, cover them with cheesecloth and lay them out to dry, turning occasionally. (Traditionally, they were dried in the sun).

*This process takes about two days. The patties may be stored in a tightly covered container for future use and can be used to make berry sauce ("Native American Recipes," 2018).

WOJAPI (DAKOTA BERRY SAUCE)

Makes about 4 cups

- 4 cups blueberries or chokecherries, fresh or frozen
- 1-2 tablespoons cornstarch or arrowroot (Traditionally would have been arrowroot)
- Maple syrup (May have used some syrup, depending on time period)
- ¼ cup water

In a saucepan, simmer berries and water over low heat, stirring occasionally. (If using fresh berries, you may need more water to keep them from scorching.) Once the berries are broken down into a sauce, spoon out some sauce and whisk in the thickener. Fresh berries should need 1

tablespoon, frozen might need 2 tablespoons thickener. Whisk until completely dissolved, then add back to the rest of the sauce. Sweeten to taste with maple syrup. Serve on cornbread or ice cream ("Native American Recipes," 2018).

Squash. Squash were prepared by boiling them whole in water or roasting them under the ashes of the fire (Gilmore, 1919)(p.94).

THREE SISTERS SOUP (From Donna LaChapelle and Patricia Chandler)

Makes 4 servings

- 3 tablespoons butter (bison tallow)
- 4 cups chicken or vegetable stock (possibly bison hoof broth)
- 1 cup onion, diced
- 1 clove garlic, minced
- 1 butternut or acorn squash, pre-baked and pureed (Not pureed)
- 1 teaspoon curry powder
- ½ teaspoon salt (Not traditionally)
- ½ cup yellow corn kernels
- ¼ teaspoon ground coriander
- ½ cup hominy, cooked
- 1 cup white beans, cooked
- 1⁄8 teaspoon crushed red pepper

Melt butter in a large saucepan over medium-high heat. Add onion and garlic, cook for 3 to 5 minutes or until tender. Stir in spices, cook for 1 minute. Add stock, corn, hominy, and beans, and bring to a boil. Reduce heat to low and cook, stirring occasionally, for 15-20 minutes to develop flavors. Stir in pureed squash, cook for 5 minutes or until heated through. Serve warm with chives and plain yogurt as a garnish. (There may have been fewer spices originally, though they did use a lot of different plants, so it's possible there were spices.) ("Native American Recipes," 2018)

Sap. Several tribes made sugar from the sap of soft maple and box elder trees. Women notched the tree and put a piece of wood below the notch so that the sap trickled down the piece of wood and drip onto a pannikin made of birch bark. They then boiled the sap down in kettles making hard sugar cakes (Gilmore, 1919; Johnston, 1970)(pp.67-68). **(When did they start doing this?)**

Other plants. Nodding onion bulbs and leaves were eaten raw or used as flavoring (Johnston, 1970). Other wild onions were eaten raw and fresh as a relish, cooked to flavor meat or soup, or

fried (Gilmore, 1919)(p.27). Hyssop leaves (*Agastache foeniculum*) were used for flavoring foods. Wild mint leaves (*Mentha arvensis* L. var. *villosa*) were used to flavor pemmican or meat (Johnston, 1970). The Omaha boiled sour dock leaves for food (Gilmore, 1919)(p.37). Milkweed was eaten during all three stages of its growth. The sprouts, which are similar to asparagus sprouts, were eaten in the early spring. The floral buds were eaten, as were the young fruits while they were still firm and green. In all cases, they boiled the milkweed. They prepared white-bark pine for consumption by peeling off the outer bark and scraping out the inner bark for food. The inner bark of western red cedar was also eaten fresh or pressed into cakes for later consumption. They ate the seeds of arrow-grass by parching them first (Johnston, 1970).

Fungi. Oyster mushrooms were mild in flavor with an indistinct odor. Tree ear and morel mushrooms were boiled prior to eating. They were mild and tender, unless they grew on ash trees, which made them bitter (Gilmore, 1919)(pp.15-17).

Nuts and seeds. Black walnuts, hazelnuts, and hickory nuts were eaten raw, served with honey, or made into soup (Gilmore, 1919)(pp.32-33). Wild blue flax seeds were added to foods because of their high nutritional value and the flavor they added to food (Gilmore, 1919)(p.64).

Fuel used for fires/cooking

Data from 1200-1400 AD indicate that Paleo-Indians used dung for fuel. The data included samples from hearths, roasting pits, and ash dumps. Specifically, the presence of grass and sedge seeds in samples suggest that dung was used as fuel. Dung was likely used as fuel when the environment of the area in which the Indians lived was low in wood. This was the case in the short-grass grassland environments found in areas such as the Texas panhandle (Miller & Smart, 1984).

Fire pits were used by the Plains Indians during the Archaic periods.

Sharing and culture related to food

Meals. There was no particular time for meals and they typically had some meat on the fire all day (Wissler & Thomas, 1986)(p.21). “The Plains Indians believed in brotherhood and honesty and sharing” (Carlson, 1998)(p.112). They had what was called ‘The Eternal cooking Meal”, where they kept a container, often a large bowl made from a gourd or a wooden bowl, full of some kind of stew and simmering with hot stones in it. Anyone could eat the stew when they were hungry. When food was taken out of the container, some more was added, for example, if a piece of meat was taken out of the stew, it was replaced. Water was added as needed. There was no set meal time, hence the name ‘The Eternal Cooking Meal’, and people dipped into the containers for food when they were hungry. Also, guests were always fed, with the traditional greeting to guests being “Have you eaten?”. It was the duty of tribes and families to always keep the meal cooking, regardless of whether it was lean times or not (Oxendine, 2014).

Religious beliefs. The vastness of the Great Plains inspired much of the Plains Indians’ beliefs, and they found the plains enchanting and mysterious. This quote from an Omaha Indian represents this idea: “The country was very beautiful…in both the woodland and the prairie I could see… many forms of life, beautiful living creatures which *Wakanda* [the Holy One Above]

had placed here" (Carlson)(p.111). They viewed the Great Plains in the way we might think of Mother Earth, providing for their need and livelihood, and served as the center of the interconnectedness of all things. The Plains Indians believed that a conscious life existed in all animal and plant beings, in natural objects, and in unknown powers. They believed in the interconnectedness of all phenomena.

Their cosmological system did not have the concept of private ownership, because mother Earth could not be divided. Also, they saw little need to save food or material goods for the future, and as such, these goods were meant to be shared, not hoarded. They also considered time of minor concern. "Hours, minutes, and seconds were such small divisions of time, that we had never thought of them. When the sun rose, when it was high in the sky, and when it set were all the divisions of the day that we had ever found necessary"- Carl Sweezy, an Arapaho (Carlson p. 111). "Nature dictated the time to hunt, the time to plant, the time to pick berries." A Lakota word for July translated into "Moon of the Red Cherries" and one for January meant "Moon of Frost in Tipis."

The bison was incredibly important to the Plains Indians: "Probably no animal anywhere affected any people to the degree that bison affected people of the plains." "To us, the buffalo was more than an animal. It was the stuff of life."-First Boy, an Assinboin. In fact, the Plains people had legends about the bison herds and believed the bison was a spiritual force in their world. Folklore among some Plains Indians held that all the bison in a herd must be slaughter so that an escaping bison couldn't warn other nearby herds (Carlson, 1998)(pp.39-40).

Different tribes had taboos for particular foods. For example, the Crows and Comanches considered fish taboo. Raw bison heart symbolized the animal's bravery and strength (Carlson, 1998)(p.56).

Overall, the Plains Indians differed in their religious beliefs and did not share any one epistemology, ontology, or phenomenology. "They admired bravery, fortitude, wisdom, and generosity, as well as honesty, loyalty, and courtesy" (Carlson p.111). Overall, their spiritual activity was fundamental to their lives, and they did not separate the secular and sacred life. Because of this lack of separation, they managed to transform daily tasks into rituals, rites, and prayers, and they regularly asked for spiritual assistance. They main goal in life was to "become one with the spirit world". Many Plains Indians recognized a principal God, or spirit being, known as the Holy One Above. The Holy One Above was omniscient and all-powerful. It lived in the sky and was the creator who gave sacred power to all elements of life. This was who they addressed in prayers and who they offered smoke to first during ceremonies. There were both benevolent and malevolent spirits in the world (Carlson).

Religious practices differed between tribes, but common practices included using sweat lodges for purification, altars, reverential pipe smoking, symbolic painting of the face and body, imitating or impersonating events or spirits, and music and dancing. They often had ceremonies that were associated with the movement of the sun and stars throughout the year. "For all Plains Indians, the cardinal points of the compass, the number four, and circle or hoop were sacred". The circle symbolized harmony, and was the essence of unity and wholeness. They often

pitched their tipis in circles and sat in circles during important ceremonies. Medicine wheels are ceremonial sites made of stones placed in a circle, and are often associated with events like the summer solstice. These have been found throughout the northwestern plains. Like the circle, the number four symbolized natural harmony because there were four seasons, four ages in human life (babyhood, childhood, adulthood, and old age), four elements above the earth (sun, moon, stars, sky), and other natural manifestations of the number four, like the four directions of the compass (Carlson).

In ceremonial uses of sweat lodges, people smoked, prayed, and tried to receive visions. They cleansed themselves with sage and cold water after leaving the sweat lodge. Tobacco was ritualistic, in part because it was so strong. They made a special concoction known as Kinnikinnick, which had tobacco, dried red willow bark, bearberry leaves, sumac leaves, cottonwood, and other aromatic herbs, like marijuana. They stored the Kinnikinnick in small, elaborately decorated pouches. Smoking tobacco was the most widely practiced rite among the Plains Indians (Carlson). Smoking was predominantly a male activity.

Among the nomadic tribes, religion was primarily individualistic and focused on personal visions. There were some group ceremonies, typically in the early summer when they were gathered together to prepare for large bison hunts, but overall, religion was private and there was wide variety in the form religion took for individuals. The personal-vision quest represented one nearly universal religious element among nomadic tribes. The goal of the quest was to obtain a vision and, often, to befriend a spirit animal. The vision quest was solitary, and people fasted and thirsted for 3-4 days until they had a revelation in the form of a dream or trance. Many tribes specifically had adolescent males go on vision quests; however, it was common for an individual to seek a vision if a special reason called for it. Shaman helped those who struggled having a vision. Common spirits, which became the person's guardian spirit, were bison, elk, bear, eagles, hawks, dogs, and rabbits (Carlson)(pp.115-117).

One tribe, the Skidi Pawnee, practiced human sacrifice in their ceremonies well into the nineteenth century. Other Pawnee tribes disapproved of the practice. They captured a girl, typically around age 13, and had a four-day ceremony. At the end of the ceremony, the girl stood on a special platform and faced the morning star (a bright planet like Venus or Mars) and was shot through the breast with an arrow. A priest cut out her breast and smeared her blood over his face and body, with the rest of the community continuing to shoot the corpse (Carlson p.119).

The well-known Sun Dance ceremony actually wasn't developed until after 1700, likely by the Arapaho or the Cheyennes, and its use spread rapidly after 1750. Individuals did the son dance to help them avenge a death, lead a successful bison hunt, give thanks for good fortune, to ensure wealth and happiness, and for other reasons. "Men who had made special vows danced for from one to four days and nights to the accompaniment of drumming and singing. The dancers often underwent various ritualistic self-sacrifices, including fasting, thirsting, and mutilations, in their quest for power, good health, thanksgiving, success, and general welfare" (Carlson p.120). This was performed by nomadic and semi-sedentary tribes and its practice between tribes was largely homogenous. Among the Lakota, two delicacies were consumed through the Sun Dance ceremony- dog meat and bison tongue. The Lakota's Sun Dance ritual

was masochistic in their practice of placing wooden skewer through the flesh of volunteers' backs, breasts, and legs, whose goal it was to break free of the skewers by tearing their flesh. The Sun Dance was the most unifying of rituals: "they came together at one time during the year for a deeply emotional religious experience in which supernatural aid was called upon to assure the tribe a plentiful supply of bison for the coming year" (Carlson p.122). In general, the overall goal of the Sun Dance for all tribes was to bring good healthy, fertility, and sustenance, and to restore tribal harmony and renew the world (Carlson p.123).

Trade. Plains Indians have traded for centuries, with trade beginning before 2000 BC. Plains Indians traded within their tribes, between tribes, and with European Americans. Trade within tribes consisted of gift-giving and obtaining social status and needed items. Trading between tribes focused on exchanging items from the hunt, like dried meat, tallow, or skins, for agricultural products like corn, squash, and beans. From AD 1400 to 1500 there was a trade network called the Middle Missouri system and part of this system included an annual rendezvous on the James River in South Dakota (Schlesier, 1994)(p.89).

Trade with European Americans began after the 1600s and primarily focused on horses, guns, and metal products. In Santa Fe, Indians traded hides, foods, and services with European Americans for beads, mirrors, and blades. In the early 1800s, Americans and Europeans traded manufactured products for bison robes, beaver pelts, and other skins and furs (*Encyclopedia of the Great Plains Indians*, 2007)(pp.204-205). Northern plains Indians traded pemmican with whites (Carlson, 1998)(p.57).

At the time of European contact there were two types of trading sites in the Great Plains. The first type of trade site was associated with permanent agricultural villages. These sites hosted trading parties between tribes. The second type of trading site was a trade fair. Trade fairs took place at a rendezvous away from a permanent village at a place that was mutually convenient to the various nomadic tribes. Trade systems included middlemen who served as intermediaries between different tribes. They also used the calumet ceremony, which made unrelated peoples one family, allowing for trade between traditional enemies. Trade allowed tribes to acquire foods that would otherwise have been difficult for them to obtain. Interestingly, the Plains Indians often traded corn for corn or meat for meat. While this appears pointless on the surface, the purpose of this redundant trading was to maintain trade avenues in case of crop failure. Native American sign language was a necessary component of trade because it allowed linguistically diverse tribes to negotiate trades (*Encyclopedia of the Great Plains Indians*, 2007)(pp.204-205).

Division of labor among men and women. Despite some beliefs to the contrary, many Plains Indians tribes were egalitarian in that, while men and women had separate responsibilities, those responsibilities were considered complementary and equally essential to one another (LaFramboise, Heyle, & Ozer, 1990). However, women played a subordinate role in religious ceremonies and did not have formal political power. Women did have other forms of power, including the right to own items, like the tipi and all of its contents, the right to trade, and the right to divorce. Women also maintained religious items, which was an incredibly important responsibility (*Encyclopedia of the Great Plains Indians*, 2007)(pp.71-72)(Prine Pauls, 2018).

The sexual division of labor among Plains Indians was very strict. This division of labor persisted for a long time because it helped keep the family and tribe intact.

Women were responsible for gathering and raising plant-based foods, gathering firewood, cooking, building and maintaining the home (whether it was a tipi, wickiup, or earth lodge), providing clothing and making household items, and bearing and rearing children. Young girls learned the skills needed for adulthood early in life and were given dolls and, later, child-sized hide-scraping tools, to help them learn their skills (*Encyclopedia of the Great Plains Indians*, 2007)(pp.71-72)(Prine Pauls, 2018).

Men were responsible for hunting to provide meat for their entire household, making weapons, and overseeing political and religious operations. They were responsible for protecting the whole community by engaging in either offensive or defensive warfare. Boys were given bows and arrows with dull tips and often had shooting matches and play battles with each other to learn how to protect the community. They also started learning how to stalk game and hunt moving targets during childhood. Public recognition and praise were given to children when they successfully completed a task to reinforce their 'good', successful behavior (*Encyclopedia of the Great Plains Indians*, 2007)(pp.71-72)(Prine Pauls, 2018).

Berdaches. Berdaches were Native Americans who could not be classified as either men or women. Rather, they represented a third gender role that combined traits unique to men and women. Male berdaches had relationships with non-berdache men, did women's work, and cross-dressed or combined male and female clothing. Only the Cheyenne Indians had female berdaches. Individuals became berdaches because they preferred the work of the other sex and/or had specific dreams or visions. Berdaches had distinct religious roles and were often healers or had the ability to predict the future or give people luck (*Encyclopedia of the Great Plains Indians*, 2007)(p.37). Berdaches sometimes became secondary wives of famous men (Carlson, 1998)(p.90).

Marriage/Divorce. Double-standards prevailed among Plains Indians when it came to courtship and romance. The elders watched young women's behavior but expected young men to be philanderers. Sexual chastity among women was highly prized. Women wanted a husband who was a good hunter and courageous warrior, and a man who could provide meat, hides, horses, and protect the family. Men wanted a modest, virtuous woman skilled in beading and tanning. He also wanted his wife to be a hard worker, a good wife, and mother. Physical attraction was important to both men and women seeking a partner (of course it was…). In general, the Plains Indians were vain about their appearance and spent a lot of time grooming and preparing their hair and dress. Among the Cheyenne, a courtship could last four to six years, with the woman have greater power in the choice. Arranged marriages sometimes happened. Marriages happened after the groom's family compensated the bride's family (for her reproductive loss) by giving horses, gifts, or personal services. The larger the gift, the greater the bride's status. In some tribes, like the Mandans, families exchanged equal gifts. Men typically married in their early twenties, while women often married before age sixteen. Women often lived in her husband's band or village. Most people practice levirate and sororate marriage conventions. (Levirate-A man marries his dead brother's wife. Sororate a woman marries her dead sister's husband.)

Several Plains groups practiced polygyny, particularly among their headmen and prominent leaders, whose social responsibilities often necessitated having the help of multiple wives. People often viewed the second wife as a 'chore wife' or helper, and the first wife dominated the household. Overall, however, most marriages were monogamous. Marriages were public affairs because everyone in the community needed to know about the marriage in order to regulate sexual activity (Carlson, 1998)(pp.87-89).

The Plains Indians permitted divorce. Either partner could dissolve a marriage simply by living apart. For example, a woman could divorce her husband by removing his personal property from the tipi. Men could divorce their wives for slothfulness, laziness, adultery, or excessive nagging. In some groups, the man might publicly humiliate his wife by disregarding her at a village ceremony. In some communities, an adulterous wife could have the tip of her nose cut off, though this was uncommon (Carlson, 1998)(p.90).

Birth and Death. Children, especially male children, were particularly welcomed in society. Adults celebrated birth and preserved the umbilical cord in a bag shaped like a lizard, as a symbol of long life, which was either worn in a bag around the infant's neck or was fastened to a tree or cradle board. This was supposed to protect babies from injury. Among nomadic tribes, birth spacing was important because women couldn't carry infants on long treks across the plains or nurse two children. Women breastfed for at least two, and up to five or six, years. "Not till a child was five or six years of age did parents allow themselves another offspring…Lakota families were not large, four or five children being the rule."-Luther Standing Bear (Carlson, 1998)(pp.83-84).

Plains Indians didn't fear death and considered it a part of nature's cycle that completed the normal round of life. They believed all people went to the same afterworld and that life in the afterworld was very similar to life on earth. An elderly person who was dying might dispose of his or her property and leave the village, finding a quiet place to die. Some bands would abandon elderly people if they could no longer care for them. The death of an elderly person was mourned for a brief period of time; however, deaths of children or active adults caused intense, prolonged grief (Carlson, 1998)(pp.107-108).

Ingestion

There are not any unique adaptations related to the teeth, mouth, or jaw in the Plains Indians. The wear on Plains Indians teeth does indicate sex differences in diet or dental hygiene. Also, females may have used softer, milder chewing sticks than males, explaining why males had more interproximal grooves in their teeth than females. Interestingly, the presence of grooves and wear on the teeth was even on both sides of the mouth, which is unusual, as such wear is typically greater on the dominant side of the mouth. While not related to ingestion per se, the Plains Indians did practice some dental hygiene by chewing sticks made of black sampson roots, which have a mild, general anesthetic property in the mouth. Chewing sticks also have antibiotic and anti-inflammatory effects and decreases the risk of dental caries (cavities). The Plains Indians, however, typically used chewing sticks for palliative or therapeutic purposes, not necessarily to

prevent dental disease. Along with black sampson, purple coneflower, balsam root, juniper, and other plants were used for medicinal purposes (Owsley & Jantz, 1994)(pp.151-152).

Digestion

I haven't found anything about their digestion that distinguishes them from other humans.

Macronutrients in a traditional Plains Indian diet

Total caloric content of bison meat varies, with some reports suggesting the average is 130 kcal/100g (Marchello, Slanger, Milne, Fischer, & Berg, 1989) and others suggesting it is a wider range of 0.83kcal/g in shank meat to 0.02kcal/g in loin meat.

To the best of my knowledge, it seems like the Plains Indians' diet consisted of about 21% protein, 58% fat, and 22% carbohydrates (Cordain, 2000).

Fatty acids. Bison meat fat content is 2.4-4.0% of wet weight and contains about 5.4g of fat per 100g. The fatty acids in bison are a mix of 43.3% saturated fats (2.3g/100g), 45.1% mono-unsaturated fats (2.1g/100g), and 11.7% poly-unsaturated fats (0.3g/100g). Of the total fat content, the saturated fats include 1.2% myristic acid (14:0), 20.4% palmitic acid (16:0), and 21.6% stearic acid (18:0). The mono-unsaturated fats include 0.42% myristoleic acid (14:1), 2.6% palmitoleic acid (16:1), and 42.1% oleic acid (18:1). The poly-unsaturated fats include 6.6% linoleic acid (18:2), 1.9% linolenic acid (18:3), and 3.1% arachidonic acid (20:4). This equates to about 29mg of omega-3 fatty acids per 100g, and 197mg of omega-6 fatty acids per 100g. Bison meat also contains cholesterol, with amounts ranging from 62-85mg/100g (Marchello et al., 1989). USDA nutrient database: 2.42g of fat per 100g with 0.91g of saturated fat (0.03g of 14:0, 0.43g 16:0, 0.45g 18:0), 0.95g monounsaturated fat (0.06g 16:1, 0.88g 18), and 0.24g polyunsaturated fats (0.14g 18:2, 0.04g 18:3, 0.07g 20:4, no EPA or DHA), and 82mg of cholesterol. They demonstrated fat-seeking behavior (Byers 2002).

Dried trout contains 8g/100g of fat, 0.8g of which are saturated fat, 1.23g of monounsaturated fat, and 1.74 grams of unsaturated fat. The polyunsaturated fats include 0.06grams of linoleic acid, 0.037grams of linolenic acid, and 0.047grams of arachidonic acid. It also includes 0.27grams of EPA, 0.21grams of DPA, and 1.1 grams of DHA. Dried trout also includes 227mg of cholesterol/100g. Cooked trout contains 8.5g/100g of fat. This includes 1.5g saturated fat, 4.2grams monounsaturated fats, and 1.9grams polyunsaturated fats. The polyunsaturated fats in 0.2grams linoleic acid, 0.2 grams linolenic acid, and 0.2 grams arachidonic acid. It also includes 0.26 grams EPA, 0.24grams DPA, and 0.68grams DHA. Cooked trout includes 74mg/100g of cholesterol.

Grasshoppers contain 6.1g of fat per 100g. Crickets contain 5.5g of per 100g. Silk worm pupae (which is the closest I could get to the other worm pupae) contain 5.6g of fat per 100g.

Most plant-based foods were low in fat. Prairie turnips only had 0.3g of fat per serving, wild plums had 0.4g per serving (132g), chokecherries contained 1.7g per serving (75g), and wild raspberries had 0.3g per serving (61.5g). However, hazelnuts were high in fat, containing 53.0g per serving (25.4g by weight) (Phillips et al., 2014). Beaked hazelnuts contain 52.99g of fat per

100g, with 3.5g saturated, 45.7g monounsaturated, and 7.9g saturated fat. They contain 87mg omega-3 fatty acids and 7832mg omega-6 fatty acids.

Onions contain about 0.4g per 100g, but one onion only weighs about one gram, so this amount of fat is less than negligible, and is practically meaningless (Morris, Witkind, Dix, & Jacobson, 1981).

Groundcherries (aka gooseberries) contain 3.2g of fat per 1 pound. Mushrooms contain 2.7g of fat per one pound (raw). Beechnuts contain 226.8g of fat per one pound. Prickly pears contain 0.1g of fat per one pear (Morris et al., 1981) or 0.31g per 100g (nutrientdata). Chokecherries contain 1.7g of fat per 100g.

USDA nutrient database indicates boiled prairie turnips contain 0.32g of fat per 100g (USDA).

Wild plums contain 0.17g of fat per 100g.

Dried corn contains 10.64g of fat per 100g. This consists of 1.974g of saturated fats (1.599g 16:0, 0.297g 18:0, 0.058g 20:0, and 0.02g 22:0. 3.75g of monounsaturated fats, including 0.021g 16:1, 3.692g 18:1, and 0.037g 20:1. 4.543 grams of polyunsaturated fats, including 4.419g 18:2, 0.124g ALA, and 0g of omega-6 fatty acids.

Cattail shoots contain no fat per 100g. Lamb's quarters contain 0.16g of fat per 100g. Wild raspberries have 0.28mg of fat per 100g. Wild rose hips contain 0.34g fat per 100g. Stinging nettles contain 0.11g of fat per 100g.

Protein.

Bison meat protein content is about 21% of wet weight (Marchello et al., 1989). USDA nutrient database: 28.44g of protein per 100g. Dried trout includes 77.3g/100g of protein. Cooked trout includes 26.6g of protein per 100g. Grasshoppers contain 20.9g of protein/100g, crickets contain 12.9g of protein per 100g, and worm pupae contain 9.6g of protein/100g.

Squaw-root is 6.35% protein by dry weight. However, while this value is low, the overall quality of squaw-root protein is fairly high, and it has a protein score of 81 because of the amino acid composition. Jerusalem artichoke has a score of 58 and prairie turnips have a score of 36. Protein scores for other Plains Indians crops are 56 for corn and 42 for beans (Kaldy et al., 1980). Prairie turnips are low in protein, with only 1.1g per 100g when cooked (Phillips et al., 2014). According to Shanke, there is an abundance of high quality protein in Prairie turnips (3.5g/g fresh weight), which they say makes it a better nutritional source than potatoes (2g protein) or sweet potatoes (1.5g protein) (Stahnke et al., 2008).

Hazelnuts were fairly high in protein, containing 14.9g per 100g (Phillips et al., 2014). Beaked hazelnuts contain 14.89mg of protein per 100g.

Onions contain 2.2g of protein per 100g, which is also negligible (Morris et al., 1981).

Groundcherries (aka gooseberries) contain 8.6g of protein per 1 pound. Mushrooms contain 8.6g of protein per one pound (raw). Beechnuts contain 88g of protein per one pound. Prickly pears

contain 0.5g of protein per one pear (Morris et al., 1981) or 0.39g per 100g (nutritiondata). Chokecherries contain 3.0g of protein per 100g.

USDA database indicates boiled prairie turnips contain 1.64g of protein per 100g (USDA).

Wild plums contain 0.43g of protein per 100g. Dried ground corn has 14.48g of protein per 100g. Cattail shoots contain 1.18g of protein per 100g. Lamb's quarters contain 4.06g of protein per 100g. Wild raspberries have 1.12g of protein per 100g. Wild rose hips contain 1.6g protein per 100g. Stinging nettles contain 2.71g of protein per 100g.

Corn has 3.4g of protein per 100g.

Carbohydrates. Bison meat doesn't contain carbohydrates; however, the organ meat should. Since I could not find bison organ meat data, I used beef organ meat as a surrogate. Beef kidneys have 0.29g of carbohydrates. Beef liver has 3.89g of carbohydrates per 100g. Dried trout and cooked trout do not contain any carbohydrates. Grasshoppers contain 3.9g of carbohydrates per 100g, crickets contain 5.1g of carbohydrates per 100g, and silk worm pupae contain 2.3g of carbohydrates per 100g.

Prairie turnips are very fibrous, consisting of 7.5g of fiber per 100g, with 6.9g insoluble and 0.6g soluble fiber when cooked (Phillips et al., 2014). USDA indicates boiled prairie turnips contain 29.99g of carbohydrates per 100g, with 7.2g total dietary fiber and 4.74g of total sugars, and 15.8g/100g of starch (additional info in database if needed) (USDA).

Onions contain 20.8g of carbohydrates/100g (Morris et al., 1981). Groundcherries (aka gooseberries) contain 50.8g of carbohydrates per 1 pound. Mushrooms contain 29.5g of carbohydrates per one pound (raw), and beechnuts contain 92.1g of carbohydrate per pound. Prickly pears contain 10.9g of carbohydrates per one pear (Morris et al., 1981) or 21.57g per 100g (nutritiondata). Bison contains 0g of carbohydrates or fiber (USDA nutrient database). Chokecherries contain 33.6g of carbohydrate per 100g, including 20g of fiber and 9.4g of sugars.

Wild plums contain 21.95g of carbohydrates, including 6g of fiber, and 10.g of total sugars per 100g. Dried ground corn includes 66.27g of carbohydrates, with 20.5g of fiber, 21.32g of sugar (20.08g of which are sucrose), and 24.99g of starch. Cattail shoots contain 5.14g of carbohydrates per 100g, including 4.5g fiber, 0.22g sugars, and 0g of starch.

Lamb's quarters contain 7.47g of carbohydrates per 100g, including 5.2g of fiber. Wild raspberries contain 13.85g of carbohydrates per 100g, including 7.5g of fiber and 5.54 g of total sugars. Beaked hazelnuts contain 22.98g of carbohydrates per 100g, with 9.8g of fiber. Wild rose hips contain 38.22g carbohydrates per 100g, including 24.1g fiber and 2.58g sugar. Stinging nettles contain 7.49g carbohydrates per 100g, including 6.9g fiber and 0.25g sugars.

Corn contains 25.9g of carbohydrates per 100g, with 2.9g of fiber and 3.3g of sugars.

Micronutrients in a traditional Plains Indian diet

Luke-Just an FYI-the article in the DropBox by Phillips (under Plains Indians research) has a lot of good visuals for representing the nutrient content of foods. This could be a nice reference when deciding how to visually represent the nutrients.

Vitamins in a traditional Plains Indian diet

Vitamin A. Bison meat does not contain any vitamin A; however, the organ meat likely contains plenty of vitamin A. I could not find any data on bison kidneys, liver, or other organs, so I selected bison as a surrogate. As such, bison kidneys have 1397 IUs of vitamin A, with 419ug of RAEs. Beef liver has 16898 IUs of vitamin A, with 4968ugs of vitamin A, primarily in the form of retinol, beta-carotene, alpha-carotene, and beta-cryptoxanthin. Dried trout contains 213 IUs of vitamin A in the form of 64ugs of retinol. Cooked trout contains 63IUs of vitamin A in the form of 19ugs of retinol.

Chokecherries contain 8ug of vitamin A (RAEs) or 168 IUS. This is in the form of 90ug of beta-carotene, 2ug of alpha-carotene, and 19ug of beta-cryptoxanthin per 100g. Wild plums contain 173ug of RAE, or 3464 IUS of Vitamin A, including 1930ug of beta-carotene, 140ug of alpha-carotene, and 157ug of beta-cryptoxanthin per 100g. Dried corn contains 13ug of RAEs, or 261 vitamin A IUs, consisting of 117ug of beta-carotene, 18ug of alpha-carotene, and 61ug of beta-cryptoxanthin. Cattail shoots contain very little vitamin A, at only 1ug RAEs or 11 IUS, and 6ug of beta-carotene. Lamb's quarters contain 194ug RAEs or 3882IUs, consisting of 2329ug of beta-carotene. Wild raspberries contain 2ug of RAEs or 50 IUs, consisting of 13ug beta-carotene, 2ug alpha-carotene, and 31ug beta-cryptoxanthin per 100g. Beaked hazelnuts do not contain any vitamin A. Prickly pears don't have any vitamin A. Wild rose hips contain 217ugs of RAEs, or 4345 IUs, including 2350ug beta-carotene, 31ug alpha-carotene, and 483ug beta-cryptoxanthin per 100g. Stinging nettles contain 101ug RAEs, or 2011IUs, consisting of 1150ug beta-carotene and 114ug alpha-carotene.

Vitamin D. Bison does not contain any vitamin D (USDA). Bison meat does not contain any vitamin D; however, the organ meat likely contains plenty of vitamin D. I could not find any data on bison kidneys, liver, or other organs, so I selected beef as a surrogate. As such, beef kidneys have 45 IUs of vitamin D, 1.1ug of D2/D3. Beef liver has 49 IUs of vitamin D, 1.2ug of D2/D3. Dried trout contains 628IUs of vitamin D, 15.7ugs of D2/D3. Cooked trout does not contain any vitamin D.

Chokecherries do not contain any vitamin D. Wild plums do not contain any vitamin D. Dried corn does not contain any vitamin D. Cattail shoots do not contain any vitamin D. Lamb's quarters do not contain any vitamin D. Wild raspberries do not contain any vitamin D. Beaked hazelnuts do not contain any vitamin D. Prickly pears don't have any vitamin D. Wild rose hips do not contain any vitamin D. Stinging nettles do not contain any vitamin D.

Vitamin E. Bison meat contains 0.36mg of vitamin E in the form of alpha-tocopherol (USDA). Beef kidney (bison surrogate) contains 0.22mg of vitamin E in the form of alpha-tocopherol. Beef liver contains no vitamin E. Dried trout contains 2.41mgs of vitamin E in the form of alpha-tocopherol and 0.05mg of gamma tocopherol. Cooked trout does not contain any vitamin E.

Chokecherries contain 0.35mg of alpha-tocopherol, 0.03mg of beta-tocopherol, 1.06mg of gamma tocopherol, and 0.09mg of delta-tocopherol per 100g. Wild plums contain 0.53mg of alpha-tocopherol, 0.01mg of beta-tocopherol, 0.41mg of gamma-tocopherol, and 0.05mg of delta-tocopherol. Dried corn contains 0.44mg alpha-tocopherol per 100g. Cattail shoots do not contain any vitamin E. Lamb's quarters do not contain any vitamin E. Wild raspberries contain 0.57mg of alpha-tocopherol per 100g, and 0.04mg of beta-tocopherol, 2.22mg gamma-tocopherol, and 2.4mg delta-tocopherol per 100g. Beaked hazelnuts do not contain any vitamin C. Prickly pears don't have any vitamin E. Wild rose hips contain 5.84mg vitamin E per 100g, and 0.05mg beta-tocopherol, 1.34mg gamma-tocopherol, and 0.14mg delta-tocopherol.

Vitamin K. Bison meat doesn't contain vitamin K, nor do beef kidneys; however, beef liver contains a small amount of vitamin K- 3.1ug/100g. Cattail shoots contain 22.ug/100g of vitamin K. Chokecherries contain 29.3ug/100g of vitamin K. Dried and steamed corn contain very little vitamin K- 0.8 to 0.9ug/100g. Stinging nettles contain a lot of vitamin K- 498.6ug/100g. Rose hips contain 25.9ug/100g of vitamin K. Wild plums contain 11.2ug/100g of vitamin K. Wild raspberries contain 6.6ug/100g of vitamin K. Dried and cooked trout do not contain any vitamin K.

Vitamin C. Beef kidneys contain 9.4mg of vitamin C. Beef liver has 1.3mg vitamin C. Wild rose hips contain the largest amount of vitamin C, at 426mg/100g. Other plant sources are low in vitamin C. For example, the vitamin C content of tubers is: prairie turnip-0.38mg/100g, Jerusalem artichoke-0.82 mg/100g, and squaw-root-11.22 mg/100g (Kaldy et al., 1980). Wild plums have 10.3mg/100g, prickly pears have 11.3mg/100g (Phillips et al., 2014) or 6.2mg/100g (nutrition data). Dried and cooked trout do not contain any vitamin C.

Kaye suggests that prairie turnips have 17.1mg of vitamin C per 100g. USDA indicates boiled prairie turnips contain 2mg of vitamin C per 100g (USDA). Bison does not contain any vitamin C (USDA). Chokecherries contain 5.5mg of Vitamin C per 100g. Wild plums contain 10.3mg of vitamin C per 100g. Dried corn does not contain any vitamin C. Cattail shoots contain 0.7mg of vitamin C per 100g. Lamb's quarters contain 4.9mg of vitamin C per 100g. Wild raspberries contain 26.4mg of vitamin C per 100g.

Other vitamins. Bison contains 0.1mg of thiamin, 0.27mg riboflavin, 3.71mg niacin, 0.4mg B-6, 8ug folate, and 2.86mg of B-12 per 100g. USDA nutrient database indicates prairie turnips contain less than 1mg of thiamin, riboflavin, niacin, and B-6 per 100g (USDA). The only B vitamin in dried trout was B-12, with 22.4ug/100g. Cooked trout contains 0.43mg of thiamin, 0.42mg of riboflavin, 5.8mg of niacin, 2.2mg of pantothenic acid, 0.23 mg of B6, 15ug of folate, and 7.5ug of B12 per 100g.

Chokecherries contain 0.034mg thiamin, 0.173mg riboflavin, 0.628mg niacin, 0.398mg pantothenic acid, 0.198mg B-6, and 2ug folate per 100g. Wild raspberries contain 0.018mg thiamin, 0.08mg riboflavin, 1.03mg niacin, 0.3mg pantothenic acid, 0.104mg B-6, and 5ug folate per 100g. Wild plums contain 0.005mg thiamin, 0.042mg riboflavin, 0.367mg niacin, 0.301mg pantothenic acid, 0.093mg B-6, and 1ug folate per 100g. Dried corn has 0.261mg thiamin, 0.181mg riboflavin, 8.25mg niacin, 1.59mg pantothenic acid, 1.11mg B-6, and 111ug of folate

per 100g. Cattail shoots contain 0.023mg thiamin, 0.025mg riboflavin, 0.44mg niacin, 0.234mg pantothenic acid, 0.123mg B-6, and 3ug folate per 100g. Lamb's quarters contain 0.047mg thiamin, 0.27mg riboflavin, 0.623mg niacin, and 0.232mg B-6. Beaked hazelnuts contain 0.48mg thiamin, 0.16mg riboflavin, 3.19mg niacin, and 0.55mg B-6 per 100g. Prickly pears contain 0.018mg thiamin, 0.044mg riboflavin, 1mg niacin, and 0.146mg B-6 per 100g. Wild rose hips contain 0.016mg thiamin, 0.166mg riboflavin, 1.3mg niacin, 0.8mg pantothenic acid, 0.076mg B-6, and 3ug folate per 100g.

Minerals in a traditional Plains Indian diet

Sodium and Potassium. Bison sodium and potassium content vary based on the cut of meat, with values for sodium ranging from 56mg/100g to 64mg/100g and values for potassium ranging from 382 mg/100g to 442mg/100g (Marchello et al., 1989). Another source says bison hunt meat contains 76.5mg/100g of sodium and 33.5mg/100g of potassium (Morris et al., 1981). USDA nutrient database for the lean meat of roasted bison indicates that it contains 57mg/100g of sodium and 361mg/100g of potassium (USDA). Dried trout is one of the few foods that contains a lot of sodium (I'm assuming that this is because they dried using salt-not clear based on the info but it is the Shoshone Indian data), with 2850mg/100g. Dried trout also contains a lot of potassium, 1720mg/100g. Cooked trout contains 67mg of sodium and 463mg/100g potassium.

Most plant-based foods consumed by the Plains Indians are low in sodium. The plant food with the most sodium is cattail broad leaf shoots, which only have 109mg of sodium per100g. Some plant-based foods contain a fair amount of potassium. Lambsquarters have 1070mg/100g, wild plums have 364mg/100g, chokecherries have 379mg/100g, wild rose hips have 426mg/100g serving, and beaked hazelnuts have 738mg/100g serving. Prairie turnips were not a very good source of potassium, having only 108mg/100g serving.

Onions contain no practical amount of sodium, at <.15mg/onion (or<15mg/100g). Potassium content is 2.72mg/onion (272mg/100g). Groundcherries (aka gooseberries) contain negligible amounts of sodium and potassium per 1 pound. Mushrooms contain 45mg of sodium and 1701mg of potassium per one pound (raw). Beechnuts contain negligible amounts of sodium and potassium per one pound. Prickly pears contain 2mg of sodium and 166mg of potassium per pear (Morris et al., 1981).

USDA indicates prairie turnips contain 4mg of sodium per 100g and 108mg of potassium per 100g (USDA).

Chokecherries contain 5mg of sodium and 379mg of potassium per 100g.

Wild plums contain 4mg of sodium and 364mg of potassium per 100g. Dried corn contains 4mg of sodium and 775mg of potassium per 100g. Cattail shoots contain 109mg sodium and 309mg of potassium per 100g. Lamb's quarters contain 4mg of sodium and 1070mg of potassium per 100g. Wild raspberries contain 4mg of sodium and 175mg of potassium per 100g. Beaked hazelnuts contain 2mg sodium and 738mg potassium per 100g. Wild rose hips contain 4mg of sodium and 429mg of potassium per 100g. Stinging nettles contain 4mg sodium and 334mg potassium per 100g.

Calcium and Phosphorus. Calcium and phosphorus content of bison varied by cut of meat, with calcium values ranging from 5.6mg/100g to 19.5mg/100g and phosphorus values ranging from 214mg/100g to 247mg/100g (Marchello et al., 1989). Another source suggests bison hump meat contains 2.6mg/100g of calcium, and 399mg/100g of phosphorus (Morris et al., 1981). USDA nutrient database for the lean meat of roasted bison indicates that it contains 8mg/100g of calcium and 209mg/100g of phosphorus (USDA). Dried trout contains 85mg/100g of calcium and 976mg/100g of phosphorus. Cooked trout contains 55mg/100g of calcium and 314mg/100g of phosphorus. Grasshoppers contain 35.2mg/100g of calcium, crickets contain 75.8mg/100g of calcium, and worm pupae contain 41.7mg/100g of calcium.

Good plant sources of calcium include lambsquarters, with 349mg/100g, stinging nettles-452mg/100g (or 481mg), and beaked hazelnuts-441mg/100g. Smaller sources of calcium include pricklypear-10mg/100g serving, wild rose hips-169mg/100g serving, and the prairie turnip-103mg/100g (Phillips et al., 2014).

Beaked hazelnuts contain over 50% of the DRI for phosphorus, at 411mg/100g and they contain 441mg of calcium per 100g. Other sources of phosphorus include stinging nettles-87mg/100g (or 71mg), chokecherries-67mg/100g, wild rose hips-61mg/100g, and lambsquarters-56mg/100g. Prairie turnips do not have much phosphorus-31mg/100g serving (Phillips et al., 2014).

Prairie turnip data differ by source-another source (Stahnke et al., 2008) has different values for Prairie turnips that indicate they are of decent nutritional value. USDA indicates that boiled prairie turnips contain 103mg of calcium and 20mg of phosphorus per 100g (USDA). Camas root contains about 101mg of calcium and 24.7mg of phosphorus per 100g (Turner & Kuhnlein, 1983).

Onions contain about 4.38mg of calcium per one onion and 0.31mg of phosphorus.

Groundcherries contain 41mg of calcium and 181mg of phosphorus per 1 pound. Mushrooms contain 59mg of calcium and 440mg of phosphorus per 1 pound (raw). Prickly pears contain 20mg of calcium and 28mg of phosphorus per one pear (Morris et al., 1981).

Chokecherries contain 60mg of calcium and 67mg of phosphorus per 100g. Wild plums contain 11mg of calcium and 30mg of phosphorus per 100g. Dried corn contains 25mg of calcium and 344mg of phosphorus per 100g. Cattail shoots contain 54mg calcium and 45mg phosphorus per 100g. Lamb's quarters contain 349mg of calcium and 56mg of phosphorus per 100g. Wild raspberries contain 36mg of calcium and 41mg of phosphorus per 100g.

Magnesium. Bison meat contains magnesium in quantities ranging from 28.3mg/100g to 32.5mg/100g (Marchello et al., 1989). Another source suggests bison hump meat contains 17mg/100g of magnesium (Morris et al., 1981). USDA nutrient database for the lean meat of roasted bison indicates that it contains 26mg/100g of magnesium (USDA). Dried trout contains 84mg/100g of magnesium. Cooked trout contains 2mg of magnesium. Beaked hazelnuts contain over 50% of the DRI for magnesium, at 235mg/100g. Other good sources of magnesium are lambsquarters-164mg/100g, wild rose hips-69mg/100g, and pricklypear-69mg/100g. Prairie turnips have 49mg/100g and stinging nettles have 54mg/100g (or 57mg) (Phillips et al., 2014).

Onions contain 0.44mg/onion of magnesium or 44mg/100g. USDA indicates boiled prairie turnips contain 49mg of magnesium per 100g (USDA). Roasted camas roots contain 44mg of magnesium per 100g (Turner & Kuhnlein, 1983). Chokecherries contain 27mg of magnesium per 100g. Wild plums contain 8mg of magnesium per 100g. Dried corn contains 149mg of magnesium per 100g. Cattail shoots contain 63mg of magnesium per 100g. Lamb's quarters contain 164mg of magnesium per 100g. Wild raspberries contain 26mg of magnesium per 100g.

Other micronutrients-Iron, zinc, copper, manganese, and selenium. Bison meat varies in mineral content, with iron ranging from 2.7mg/100g to 4.0mg/100g, zinc ranging from 4.1-6.3mg/100g, copper ranging from 0.17-0.19mg/100g, and manganese ranging from 0.017-0.018mg/100g (Marchello et al., 1989). USDA nutrient database for the lean meat of roasted bison indicates that it contains 3.42mg/100g of iron, 3.68mg/100g of zinc, 0.008mg/100g of manganese, and 35.5ug/100g of selenium (USDA).

Dried trout contains 3mg of iron, 2mg of zinc, 0.2mg of copper, 0.1mg manganese, and 105ug of selenium per 100g. Cooked trout contains 2mg iron, 0.85mg zinc, 0.24mg copper, 1.1mg manganese, and 16.2ug selenium per 100g. Grasshoppers contain 5mg/100g of iron, crickets contain 9.5mg/100g of iron, and silk worm pupae contain 1.8mg/100g of iron.

The best plant-based sources of iron are beaked hazelnuts-3.12mg/100g, stinging nettles-1.3mg/100g (or 1.64mg), wild rose hips-1.1mg/100g, lambsquarters-1.2mg/100g, and prairie turnips-1.0mg/100g (Phillips et al., 2014).

The best plant sources of zinc (though they are still poor sources) are beaked hazelnuts-2.1mg/100g, lambsquarters-0.6mg/100g, and wild raspberries-0.5mg/100g (Phillips et al., 2014). Wild rose hips have 0.25mg zinc per 100g. Stinging nettles contain 0.34mg zinc per 100g.

Beaked hazelnuts contain over 100% of the DRI for copper, at 1.2mg/100g. Other plant-based foods are low in copper (Phillips et al., 2014). Wild rose hips contain only 0.113mg of copper per 100g. Stinging nettles contain 0.076mg of copper per 100g.

Several plants contain close to 100% of the DRI, or more, for manganese: beaked hazelnuts-7.6mg/100g, cattail shoots-7.1mg/100g, and lambsquarters-1.6mg/100g. Wild rose hips also contain a decent amount of manganese at 1mg/100g (Phillips et al., 2014). Stinging nettles contain 0.779mg manganese per 100g.

The only plant food with any appreciable amount of selenium is prairie turnips, with 14.7ug/100g, which is still an incredibly low amount (Phillips et al., 2014). Stinging nettles contain 0.3ug of selenium per 100g.

Onions contain, per onion, 0.08mg iron, 0.05mg zinc, 0.09mg copper, and 0.01mg manganese.

Groundcherries contain 4.5mg of iron per 1 pound. Mushrooms contain 6.4mg of iron per 1 pound. Prickly pears contain 0.3mg of iron per one pear (Morris et al., 1981). Chokecherries contain 0.69mg of iron, 0.33mg zinc, 0.186mg copper, and 0.417mg of manganese per 100g.

USDA indicates boiled prairie turnips contain, per 100g, 0.95mg of iron, 0.28mg of zinc, 0.038mg of copper, and 0.209mg of manganese (USDA). Roasted camas root contains 9.9mg of

iron, 1.9mg of zinc, 0.2mg of copper, and 1.0mg of manganese per 100g (Turner & Kuhnlein, 1983).

Wild plums contain 0.17mg of iron, 0.09mg zinc, 0.035mg copper, and 0.076mg of manganese per 100g. Dried corn contains 2.61mg iron, 3.06mg zinc, 0.293mg copper, 0.9mg manganese, and 56.5ug of selenium per 100g. Cattail shoots contain 0.91mg iron, 0.24mg zinc, 0.041mg copper, 0.76mg manganese, and 0.6ug of selenium per 100g. Lamb's quarters contain 1.15mg of iron, 0.61mg zinc, 0.1mg copper, and 1.56mg of manganese per 100g. Wild raspberries contain 0.64mg of iron, 0.47mg zinc, 0.097mg copper, and 0.368mg manganese per 100g.

Plains Indians Metabolism

Gut Microbiota

There are no data on Paleoindian gut microbiome. Recent research using Native Americans indicates that the diet consumed by the participants is not in any way representative of the Paleoindian diet; therefore, we do not have any data on Paleoindians' gut microbiome. This isn't surprising, as the long history of contact with Europeans and the social and cultural changes related to this contact in the Americas has resulted in the loss of native practices and cultures.

Plains Indians Health

Stature. The Plains Indians diet, with a fair reliance on agriculture, likely contributed to retarded growth, with greater reliance on agriculture associated with growth retardation of the long bones (like the femur). This growth retardation leads to short stature. Often, adoption of a diet reliant on agriculture is associated with short stature; however, this is not always the case.

Data compared individuals from the Woodland period (pre-horticultural; AD610-1033) to individuals post-Woodland period- Coalescent sample (AD1625-1817), who relied more heavily on horticulture. Among the Woodland individuals, the males were significantly larger than the females. The Coalescent males were also significantly larger than the females. The degree of sexual dimorphism was similar in both groups. There were no data to indicate differences in stature between the two samples. These data suggest Woodland-period males were 184.99cm tall (72.8 inches) and females were 174.85cm tall (68.8 inches). The Coalescent period males were 182.16cm tall (71.7 inches) and females were 172.95cm tall (68.1 inches) (Owsley & Jantz, 1994)(pp.223-231).

It seems like the data above are questionable, as other data suggest Plains Indians much shorter in stature. Specifically, males from Middle Missouri period as being 176.12cm tall (69.3 inches) and females being 168.9cm tall (66.49 inches tall). Coalescent period males were 177.37cm tall (69.8 inches) and females were 168.66cm tall (66.4 inches). Southern Plains Indians males (AD1200-1300) were 177.06cm tall (69.71 inches) and females were 167.05cm tall (65.77 inches). Percent sexual dimorphism was 7% in the Middle Missouri, 9.7% in the Coalescent, 9.8% in the Southern Plains Indians (Owsley & Jantz, 1994)(pp.239-241).

One study found a 17-21 year old Paleoindian woman who was 165 (4) cm (about 5 feet 2 inches) tall (A Paleoindian Woman from Southern Idaho). In The Prehistory of Texas, a male Paleoindian was estimated at 161-169cm, or 5'3"-5'6" in height (Perttula, 2004). The Arch Lake woman, found in Texas, is estimated to be 166.5 cm (5 ft 5.5inches) tall, though estimates vary depending on the method used from 152cm-166cm (59.9"=65.6") (Owsley, 2010)(p.52).

Lifespan. Russel Thornton's book suggests that the life expectancy of Plains Indians varied from 18.6-33years, depending on the archaeological data considered. For example, Texas Indians (Ad 850-1700) had 30.5years, Pecos Pueblo (AD800-1700) 25-42.9years, Mississippian (AD1050-1200) was 33 years, Mississippian (AD 1200-1300) 24.3 years. This is the best source I have on life expectancy in Plains Indians (Thornton, 1987).

Plains Indians often died early in life, though the causes of death were different between men and women. Women died because of the extreme toll of their hard work and high frequency of childbearing. Men died because of the dangerous nature of hunting and warfare. Men died at earlier numbers and at younger ages. This meant that, until wars among tribes and with the U.S. decreased, women outnumbered men (promoting the desire for sororal polygamy) (*Encyclopedia of the Great Plains Indians*, 2007)(pp.71-72). There was a high child mortality rate. Additionally, some tribes, like the Comanches, practiced birth control and abortion. Their lifespan was around the late 20s to early 30s, similar to that of Europeans (Deloria & Salisbury, 2002)(p.71). The only source I can find so far suggests that, in 1880s, life expectancy was 39.41 years (Roser, 2017).

Disease risk. Prior to European contact, Plains Indians experienced infections that were not very infectious. The primary diseases they had included malnutrition, anemia, tuberculosis, diseases caused by treponemas (like syphilis) and other diseases (*Encyclopedia of the Great Plains Indians*, 2007)(p.79). There were relatively few infectious diseases, which could be due to there being fewer domesticated animals or because there fewer areas with high population densities (Deloria & Salisbury, 2002)(p.71). Scurvy (due to vitamin C deficiency) was not a problem among the Plains Indians. In fact, none of the 54 Plains Indians remains examined in one study showed evidence of scurvy (Ortner, Butler, Cafarella, & Milligan, 2001).

Pre-arrival, diseases included bacillary and amoebic dysentery, viral influenza and pneumonia, arthritides, rickettsial fevers, viral fevers; American leishmaniasis (protozoan); American trypanosomiasis (parasitic protozoans); roundworms and other endoparasites; nonveneral syphilis and pinta; nutritional deficiencies; minor bacterial pathogenes, and food poisoning (Thornton, 1987).

Skeletal analyses indicated that Plains Indians tribes did not suffer from metabolic diseases (Kimmerle, 2010). Additionally, other skeletal analysis indicate that Paleoindians only experienced limited stress based on the presence of Harris lines but not enamel microdefects and hypoplasias, which indicate more severe stress (Teufel, 1996). Iron deficiency and growth retardation were effects of increased reliance on agricultural products, like maize, which occurred pre-contact to a certain degree in Plains Indians, though the production of maize increased even more after European contact. This iron deficiency also contributed to decreased

immunity and greater susceptibility to infection (Mailer & Hale, 2015). Berries traditionally consumed by Native Americans have been associated with positive health markers, like blood sugar level regulation and lipid metabolism (Mailer & Hale, 2015).

Pre-village (950AD remains) indicate that Plains Indians did suffer from tuberculosis, though the rate in these samples was only 5 out of 422 individuals (p.98). Additional data indicated the presence of metabolic disease (22/422). Iron-deficiency anemia was the most common cause of the lesions associated with metabolic diseases, accounting for 10% of cases. These incidences of iron deficiency anemia occurred during the Middle and Late Woodland populations, suggesting that these cases may be linked to the transition to maize horticulture. There were three different types of developmental defects, including lumbo-sacral transitional vertebrae, spondylolysis, and spina bifida, and the rate was relatively high considering the small number of vertebral columns and sacral vertebrae available, with a 10% incidence of spina bifida, a 28% incidence of lumbo-sacral transitional vertebrae, and a 16% rate of spondylolysis (pp.99-100). Greater dental trauma is associated with less intake of processed foods and greater intake of animal-based foods. Thus, pre-horticultural societies exhibit lesser amounts of dental trauma. 33 individuals had dental trauma, as indicated by chipped or fractured teeth. Rates of enamel hypoplasia, which is indicative of systemic stress, were low, and displayed in 25 individuals. The episodes of hypoplasia suggest stress during weaning. The researchers concluded that the overall health of the populations was good compared to later Village populations (post 950AD). They state that major chronic pathological contributors to mortality were lacking in this population, so causes of death were likely acute and deadly (Owsley & Jantz, 1994).

Relationship between resistant starch and gut microbiome? Acorns high in resistant starch.

Martin and Goodman- Iron-deficiency anemia was prevalent prior to contact in North America after the adoption of maize agriculture, but not before. The most common infectious diseases were likely staphylococcus and streptococcus, with TB and venereal and nonvenereal syphilis being more rare. Severity of periosteal reactions increased 4-fold with transition to agriculture, representing an increase in infectious diseases related to increased population density, sedentary behavior, low diet quality, and overreliance on maize. Old World diseases that occurred after contact included bubonic plague, measles, smallpox, mumps, chickenpox, influenza, cholera, diphtheria, typhus, malaria, leprosy, and yellow fever.

Archaeological data also suggest a relatively high prevalence of spina bifida, a neural tube defect often associated with folate deficiency (this is why folate is enriched in grain products in the US) (Owsley & Jantz, 1994).

Nutrigenetic adaptations

American Indians have genetic variants of the gene nicotinic acetylcholine receptor (nAChR), which is associated with nicotine dependence and, in American Indians, their genetic variants of this gene contribute to insulin resistance and type 2 diabetes (Yang et al., 2012). Genetic variants in the nAChR gene family also contribute to subclinical atherosclerosis in American Indians (Yang et al., 2013) and are related to abdominal obesity, but not general obesity (Zhu, Yang, Yeh, et al., 2014). Gene variants in nAChR gene family in American Indians also contribute

renal function and kidney damage (Zhu, Yang, Li, et al., 2014). Importantly, these relationships between disease and the nAChR gene variants in American Indians are independent of cigarette smoking, meaning that even American Indians who do not smoke could still experience these diseases in relation their gene variants (Yang et al., 2012).

Genetic variants in the angiopoietin-like protein (ANGPTL) family, particularly the Arg59Trp variant ANGPTL8, which is expressed in the liver, in American Indians and Mexican Americans are associated with lower total cholesterol and lower HDL-C levels. In Pima Indians, the Hepatocyte nuclear factor 4A gene variant has a significant associated with HDL-C levels and type 2 diabetes (Paththinige, Sirisena, & Dissanayake, 2017).

Amerindians (which are a mix of Mexican and American Indian genetic backgrounds) have a high frequency of the methylenetetrahydrofolate reductase gene (MTHFR) variant, MTHFD1 G1958 AA (58%), which is associated with higher levels of plasma homocysteine due to changes in folate metabolism. Elevated levels of plasma homocysteine are associated with heart disease (Binia et al., 2014).

Similar to the Inuit, Plains Indians as selectively express different alleles of the fatty acid desaturases FADS1, FADS2, and FADS3, all of which are associated with diets high in PUFAs. These differences were to compensate for greater consumption of EPA. The mutations in these genes downregulate the production of omega-3 and omega-6 PUFAs. These genetic variations in fatty acid desaturases have a protective effect on cholesterol, triglyceride, and insulin levels. Data from theses study provide some of the first evidence of human adaptations to specific diets and to physiological responses to diets. It was previously thought that this adaptation only occurred in the Inuit; however, now it is clear that this adaptation was the result of a single adaptive event that occurred in a common ancestor of the Inuit, Plains Indians, and other Native Americans before they migrated out of Beringia (Amorim et al., 2017; University of California-Berkeley, 2015).

More details on the above information: Current day Native Americans also have a related adaptation in their expression of a specific haplotype of the enzymes responsible for synthesizing omega-3 and omega-6 long-chain polyunsaturated fatty acids. The haplotype they express, haplotype A, is expressed in 97% of their chromosomes. This haplotype is associated with lesser expression of the *FADS1* gene, meaning that people with haplotype A synthesize fewer long chain PUFAs in vivo than individuals who express haplotype D. This haplotype appeared over 600,000 years ago, and would also have been the haplotype of Plains Indians living during the Paleolithic era. Expressing haplotype A may be advantageous in present day because commonly consumed western diets are high in omega-6 long chain fatty acids. This high intake of omega 6 fatty acids in combination with a D haplotype likely increases the synthesis of the pro-inflammatory arachidonic acid, which increases the risk for atherosclerotic vascular damage. Therefore, present day Native Americans may experience some protection from this vascular damage even when consuming a western diet because of their expressing haplotype A (Ameur et al., 2012).

About 95% of Native Americans are also lactose intolerant as adults. This is actually the result of a lack of genetic adaptation. Indeed the gene that codes for lactase, the enzyme that breaks down lactose, historically 'turns off', decreasing lactase production starting around age twenty. It is actually less common for people to be lactose tolerant, as evidenced by the fact that large portions of the adult population in the world are lactose intolerant. Those groups that are lactose tolerant, namely European Americans and Europeans, along with people from southern Sudan, are lactose tolerant due to an evolutionary selection for genes that keep the lactase gene permanently turned on, and these mutations vary depending on a person's evolutionary heritage. For example, 3 different mutations resulting in lactose tolerance arose between 2700 and 6800 years ago in Africa. In Central and Eastern Europe, development of lactose tolerance likely didn't occur until about 3800 years ago (https://www2.palomar.edu/anthro/adapt/adapt_5.htm).

Other interesting factoid: Apparently, Native Americans prior to the arrival of Columbus in 1492, were genetically homogenous. Specifically, they lacked genetic polymorphisms in the major histocompatibility complex, which is important for immunity. This lack of diversity meant that they were extremely susceptible to the foreign diseases that arrived with Europeans in the late 15th century and moving forward. This significantly contributed to the rapid population declines following European contact (Deloria & Salisbury, 2002)(p.71).

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