1

Nice Genes

A New Twist on Genetics Teaches Us How a Baby Really Develops

Back in tenth-grade biology class, you were probably taught—as were we—that the unique combination of genes you received from your mom and dad (your genotype) was responsible for everything that followed: the color of your eyes, the size of your feet, your love of lasagna, your hatred for all eight-legged and no-legged creatures. To a certain extent, that's true, but over the past few years, studies have suggested that classical genetics may be only part of the picture. It's not just your genes that determine who you are, but which of those genes are turned on, or expressed, and to what degree they are expressed—a cutting-edge field called epigenetics. While you can't control which genes you pass on to your child, you do have some influence over which genes are expressed, affecting what features are seen in your baby (his phenotype). In this chapter, after giving you a brief refresher on the basic biology of what happens after your life-changing evening of romantic rasslin', we're going to introduce you to a new subject: YOU-ology—how what you eat, breathe, and even feel can affect the long-term health of your child.

Two to One: The Biology of Conception

We trust that you know the ins and outs of the process that involves his part A and her part B, so we'll skip what happens deep under the satin sheets and focus on the miracle deep below the flesh and deep inside the body—that is, how the egg and sperm come together.*

The Eggs

On the female side of the conception equation lie her eggs, which are fully formed and stowed away in her ovaries from before birth. Each mature egg contains one copy of each gene in the human genome—half the amount necessary for life. The maximum number of eggs that a woman will ever have is the number she has when she is a twenty-week-old fetus. She'll have about 7 million of them then, 600,000 when she's born, and about 400,000 at puberty. Once a woman hits puberty and menstruation begins, her ovaries release one of those eggs every twenty-eight or so days. During each cycle, even though multiple eggs start to develop, hormonal signals ensure that only a single egg will be released and the other eggs will regress. (It's not wise evolutionarily to blow them all at once, so the body gives females an approximately thirty-year window in which to conceive.) Hormones also work to mature that ready-to-drop egg and to pop a hole in its sac. That hole works as an escape hatch, so the egg can slip out of the ovary and travel down the Fallopian tube,

> **Factoid:** Though it happens rarely, women who lose their corpus luteum (through a ruptured cyst, for example) might need a progesterone supplement during the first trimester to help maintain the uterine lining until a placenta forms. Other candidates for progesterone supplementation include women who have a history of miscarriages, perimenopausal women, and those having in vitro fertilizations.

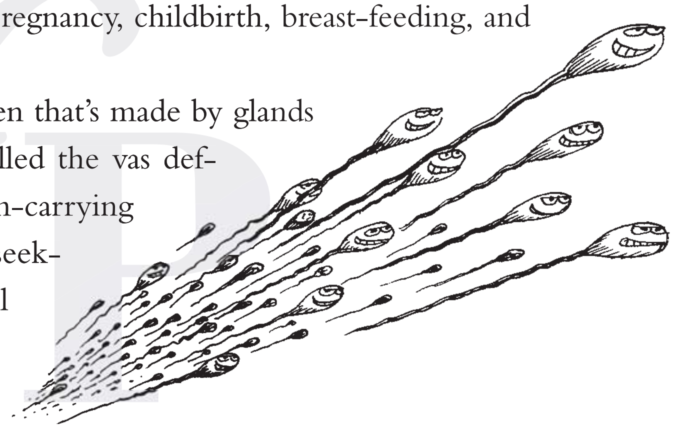
* Please cue "Let's Get It On" by Marvin Gaye.

where it may be fertilized by sperm.* Tissue left behind in the ovary after the egg is released, called the corpus luteum, will produce hormones essential to successful pregnancy if the egg is fertilized.

The Sperm

On the other side of the equation, of course, we have those little swimming sperm. As with a woman's eggs, each sperm contains a single copy of each gene in the human genome. Unlike women, men don't have a preset number of their reproductive players. In fact, a man produces more sperm in each ejaculation than the total number of eggs that a woman is endowed with for life. (Evolutionarily, a man can continue reproducing for the majority of his adult life, maximizing the chance of passing on his genes. A woman's reproductive life is limited to the younger years of her life because of the physical strain of pregnancy, childbirth, breast-feeding, and child rearing.)

A man's sperm, which is carried in semen that's made by glands such as the prostate, is stored in a duct called the vas deferens. When a man ejaculates, the sperm-carrying semen fires out through the urethra in a seek-and-conquer mission. It may seem that all these millions of sperm are racing one another to the finish. But just like a Tour de France cycling team, the sperm have different roles. Some are deemed the leaders of the pack, trying to be the first to cross the line. Others are designed to assist, specifically by blocking other men's sperm from making it to the finish line. Competitive little game going on in there, eh? The goal of pregnancy, of course, is for a sperm to find an egg during a precise window of opportunity and fertilize it.



* Interestingly, too little of these hormones may lead to infertility or miscarriage, while an abundance may lead to twins and other multiple sets. More on this in "Fertility Issues" on page 380.

Print Shop

The word *imprinting* may sound like something you've heard on *CSI,* but it's actually a form of epigenetics. Even though two copies of a given gene are inherited, one from mom and one from dad, in certain circumstances, one is permanently turned off. The nonexpressed copy is said to be imprinted. As of now, we know of at least eighty genes that are imprinted by epigenetic markers, causing them to be active or inactive in the offspring based on parent of origin. In general, expressed genes that are inherited from the mother conserve maternal resources and limit fetal growth, while expressed genes inherited from the father promote fetal growth, even if it means hurting the mother.

Problems can occur when genes that are supposed to be imprinted, or turned off, are not, or when the wrong parent's gene is imprinted. The gene for the chemical messenger called insulinlike growth factor 2 (IGF2) is normally turned on from the father and off from the mother. If the mother's copy is not turned off, the child can develop Wilms' tumor, a cancer of the kidney. Loss of imprinting of the mother's IGF2 gene later in life can contribute to age-related cancers, including cancers of the prostate and colon.

The Union

The purpose of an orgasm isn't solely to make you feel good or provide gossip fodder for the neighbors. The biological purpose is to better the odds that this union between sperm and egg takes place.

On the woman's side, the mucous membranes that line the vaginal walls release fluids during intercourse so that the penis can slide with just the right amount of friction. As intensity and sensations build, the woman's brain tells the vagina and nearby muscles to contract. That contraction brings the penis in deeper. Why does that matter? It increases the chance of his sperm getting closer to the target. During an orgasm, the cervix, located at the top of the vagina, dips down like an anteater and sucks semen up into the cervix (the cervix is a passageway connecting the top of the vagina and bottom of the uterus). The sperm is trapped in the cervical mucus

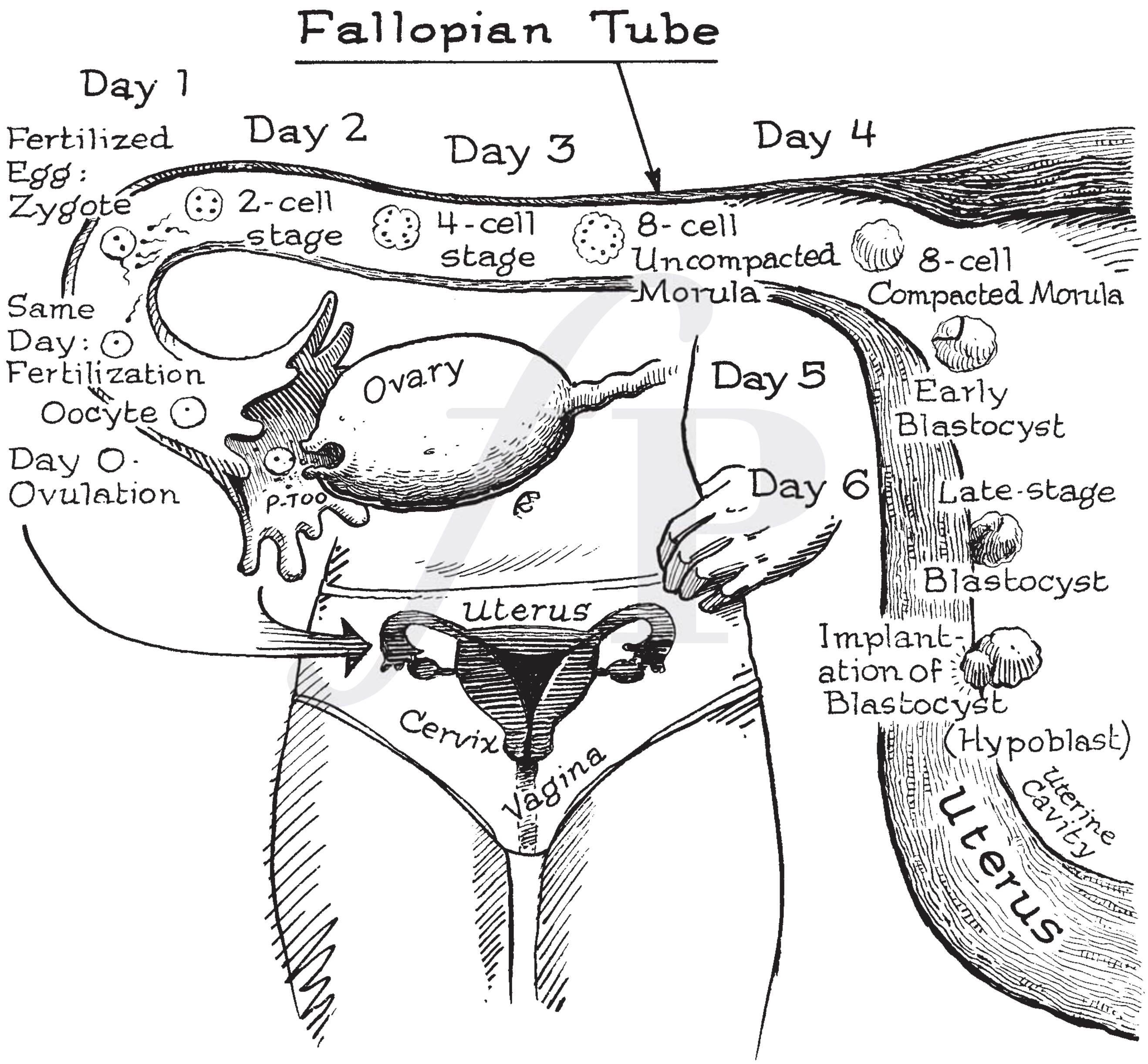


Figure 1.1 **Tube Ride** In the Fallopian tube, an egg has about twenty-four hours in which it may be fertilized. Once the sperm does so, the fragile combo, the blastocyst, multiplies its cells and must implant in the uterine wall to endure the 280-day pregnancy. Even if you try to summit Everest, this is the most dangerous journey you will ever take.

What's Age Got to Do With It?

We all know plenty of people who have made the classic clock-ticking jokes about aging women who want kids. But what does that really mean? Before ovulation, eggs have two copies of each of the twenty-three chromosomes. They're lined up waiting for the signal to divide for mom's entire life. Unfortunately, the little spindles that pull chromosomes apart don't work as well when they've been waiting for four decades. Instead of a clean break, two copies may be pulled to one side and none to the other. That's what leads to an increased risk of chromosomal abnormalities such as Down syndrome and an increase in miscarriages in older moms.

Now, that doesn't let pop totally off the hook. Older men's (as in over 35) sperm have been linked to an increase in birth defects and autism, as well as an increased difficulty conceiving. New evidence even suggests that children born to older dads score lower on various brain tests through the age of seven.

While older parents may be better equipped to handle some aspects of pregnancy and child rearing (like some of the stresses and emotional wear and tear), and may be better able to support their children financially, there are some physiological trade-offs that you'll want to consider if you are making a decision about when to have children.

until the release of the egg, and a signal then lets the sperm start the competitive swim up into the uterus.

While it's by no means necessary to have an orgasm to get pregnant, women who orgasm between one minute before and forty-five minutes after their partner's ejaculation have a higher tendency to retain sperm than those who don't have an orgasm. On the man's side, orgasm is required, because during orgasm fireworks in the brain cause involuntary contractions in lots of muscles in his body. Those contractions help him penetrate deeper and squeeze the prostate to eject sperm deep into the vagina.

Now, the actual fertilization process happens this way: After the egg drops from the ovary, it travels through the Fallopian tube, where there's about a twenty-four-hour window when it can be fertilized. Since sperm live for up to a week in the cervix (they die after a few minutes of hitting the air), it's not necessary for two people to have sex precisely when ovulation occurs, as many assume. In fact, conception is more likely to happen if sex occurs a couple days before the egg is released from the ovary. (See "Fertility Issues" on page 380 for more about getting the timing right.)

If all goes according to plan, the sperm meets the egg in the Fallopian tube, and the two half genomes unite to form a complete set of genes containing all the DNA necessary to make a new human being. The fertilized egg says thank you very much and moves along to the uterus. There it will attach to the uterine lining and begin the amazing process of becoming a baby.

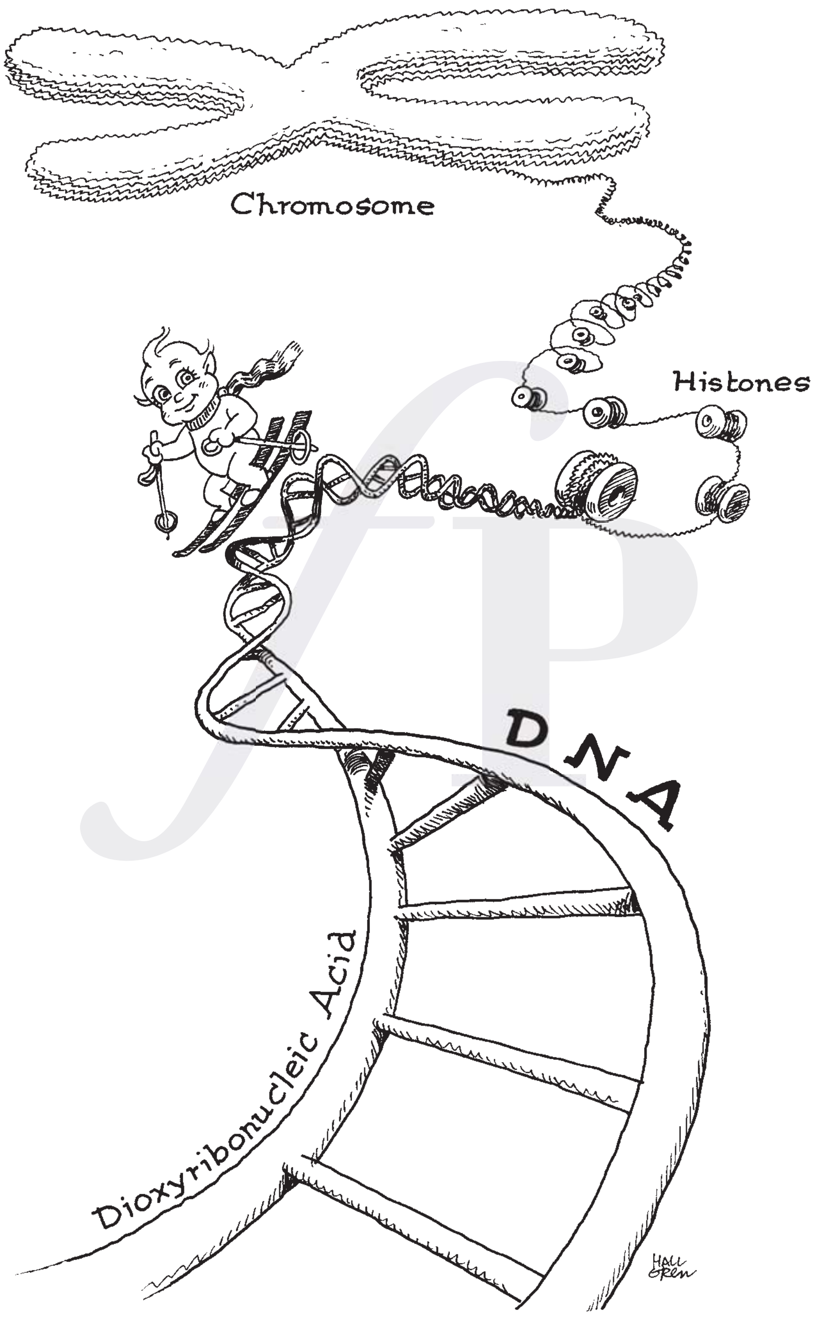
YOU-ology: A New Approach to Genes

One of the most miraculous processes in nature, aside from the formation of such things as the Grand Canyon and the hammerhead shark, has to be how we grow from a single fertilized egg cell to the trillions of cells that make up a new person.

Human cells have twenty-three pairs of chromosomes, structures that hold our DNA. The DNA acts as a complete set of instructions that tells our bodies how to develop. Individual genes are short sequences of these instructions that regulate each of our traits. (See figure 1.2.) As you might imagine, given the fact that virtually every person in this world looks different from every other, the nearly infinite possible combinations of maternal and paternal DNA are what give us our individuality. When maternal brown eyes and maternal red hair get paired with paternal blue eyes and paternal blond hair, there are four possible combinations for offspring, right? Brown eyes–blond hair, brown eyes–red hair, blue eyes–blond hair, blue eyes–red hair. Extrapolate that scenario out to twenty-three chromosomes, and the possible combinations become mind-boggling, unless scientific notation is your thing: 2^{23}, or about 8.3 million, combinations—meaning that there's about a 1 in 8 million chance that the same mother and the same father would have two kids with the exact same coding (excluding identical twins). (See figure 1.3.)

But that's only part of the story. Consider identical twins. They get dealt exactly the same DNA, but they may develop different traits down the line: One may have allergies and the other may not, one may develop a particular disease and the other

Figure 1.2 **All Wound Up** Storing more data than any computer, each chromosome contains all the information needed to give you a base for your physical and emotional characteristics. What we can learn from epigenetics is that you have the power to influence the course of biological destiny.



may not, one may be able to play the piano without ever learning how to read music, while the other can't carry a tune with a dump truck. What accounts for these differences? Something in their environment—potentially as early as in utero—affected the expression of their genes differently. That something is called epigenetics.

Here's how it works:

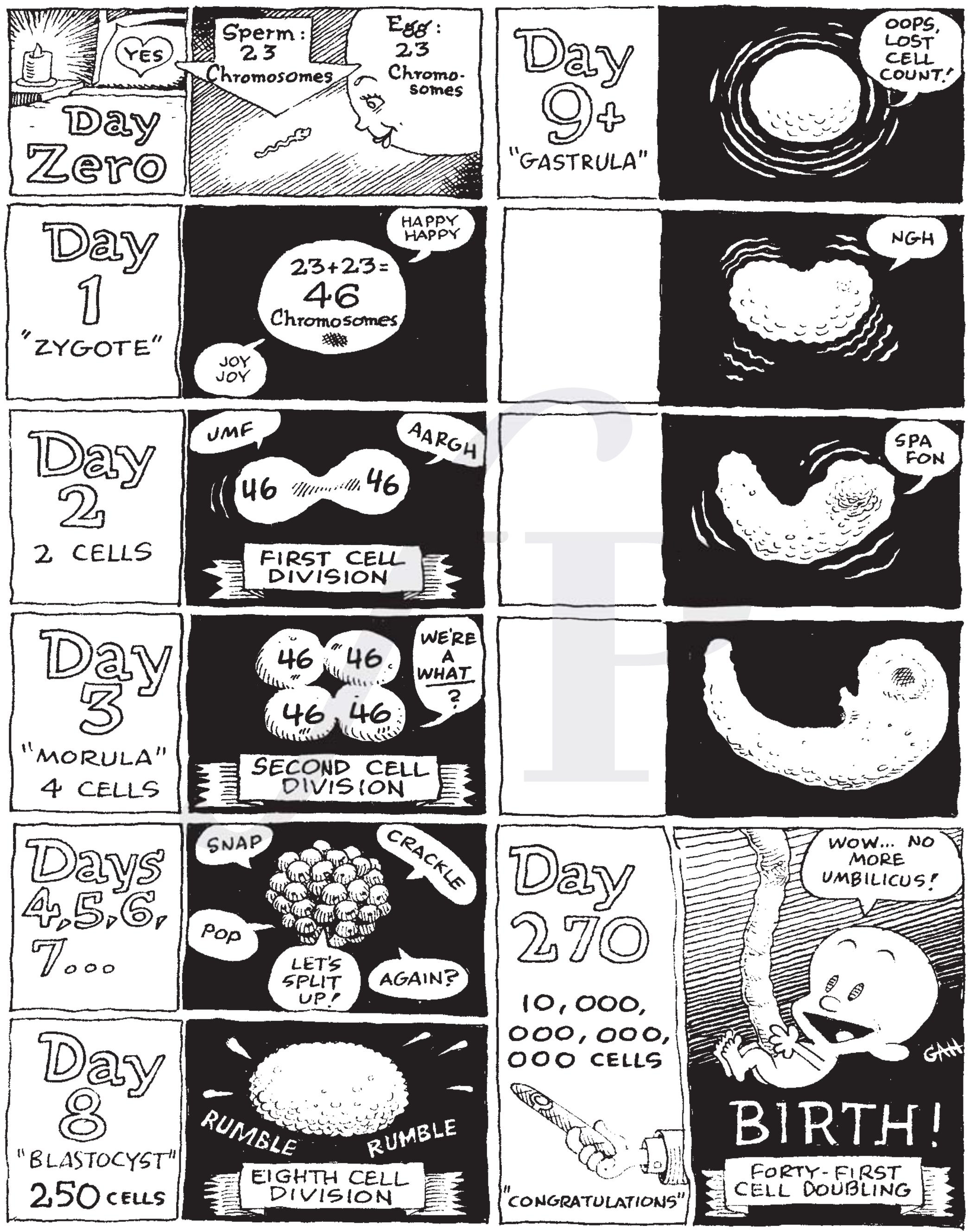
Each cell in the human body contains about 2 meters of DNA that's packed into a tiny nucleus that's only about 5 micrometers in diameter. That's the rough equivalent of stuffing two thousand *miles* of sewing thread into a space the size of a tennis ball. As with thread, DNA is wound around spools of proteins called histones. Not all of your DNA gets expressed, or used to create proteins, in every cell; in fact, most of the spools of DNA in each cell are stored away, some never to be seen or heard of again.

A good way to visualize the process: Let's say that you and your partner each comes to your relationship with a set of favorite family recipes. You may contribute a blue-ribbon chili recipe, and your significant other may bring a killer lemon meringue pie to the table. But it's not just two recipes, it's hundreds, maybe thousands. (The human genome has some twenty to thirty thousand genes, after all.) Some on index cards, some in books, some on torn-up shreds of cocktail napkins. So what do you do with all these cranberry mold recipes? Stuff each and every one of them in the kitchen drawer. Now it's hard to sift through them, you don't have access to many of them, and you really can't find what you want. Unless . . . (you knew there was an "unless" coming) you get them organized, say, by sticking hot pink Post-it notes on the recipes you really want to access quickly. You tag your favorite recipes, so you can quickly search, find, and *put them into action*.

That's the way epigenetics works.

Genes are like recipes—they're instructions to build something. Both mom and dad contribute a copy of their entire recipe book to their offspring, but for many genes, only one copy of each recipe will be used by the baby. Mom and dad have the same recipes (one for eye color, one for hair color, one for toenail growth rate, and so on), except they may have slightly different *versions* of those recipes (they're called alleles). For example, eye genes are either brown or blue or green. For such genes,

Figure 1.3 **Cell Power** On day one, we start with a single fertilized egg (called a zygote). Then cells divide and divide and divide, forming the biological structure of the fetus. By the end of the pregnancy, cells have divided a whopping forty-one times to end up with trillions of cells.



you express only the gene from your mom or dad—that is, only one copy is active, but not both. In some cases, neither copy will need to be expressed: Eye color matters only to eye cells; a liver cell doesn't need either mom's or dad's eye color gene to be cranking away.

So how does a cell turn off the 24,999 genes it doesn't need and turn on the few it does? Every cell—and there are around 200 different types in the body—needs to know which few genes are relevant for it, and, of those genes, whether mom's or dad's is going to be expressed. As with the kitchen drawer full of recipes, the genes alone are useless unless there's a way to find what you need when you need it.

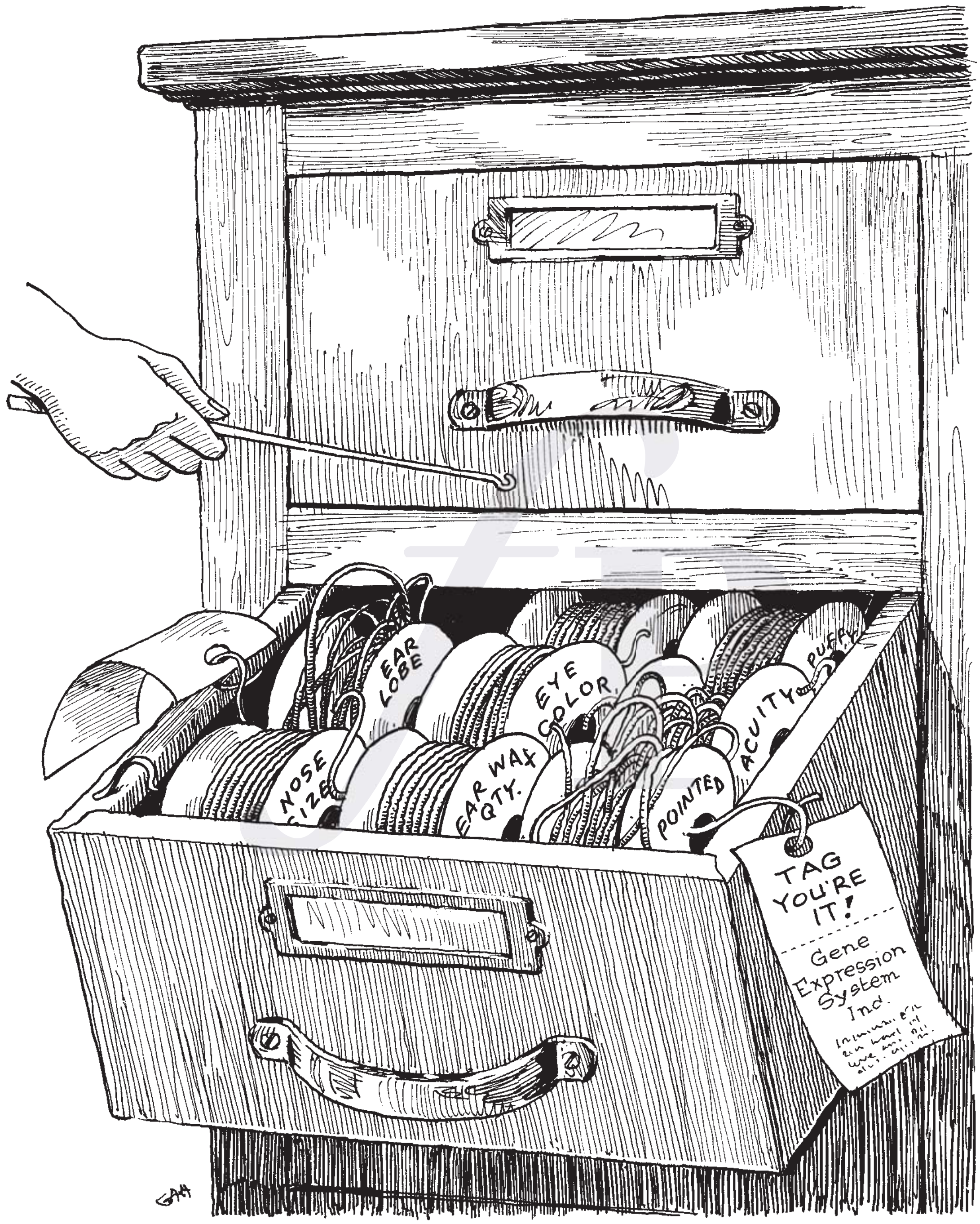
There is. Your body puts biological Post-it notes called epigenetic tags on certain genes to determine which genetic recipes get used. This tagging happens through a couple of chemical processes (such as methylation and acetylation), but guess what? Actions you take during your pregnancy can influence these processes and determine where the Post-it notes go and which genes will be expressed, ultimately affecting the health of your child. (See figure 1.4.)

When DNA gets tagged, it changes from being tightly wound around those histone proteins to being loosely wound, making the genes accessible and able to be expressed. At any given time, only 4 percent of your genes are in this accessible state, while the rest can't be actively used in the body. By determining which genes are turned off and which are turned on, epigenetics is what makes you unique.

Here's a point that will help you put epigenetics in perspective: We share 99.8 percent of the same DNA as a monkey, and any two babies share 99.9 percent of the same DNA. Heck, we even have 50 percent of the same DNA as a banana.* So genes alone cannot explain the diversity in the way we look, act, behave, and develop. How those genes are expressed plays a huge role in how vastly different we are from monkeys and how explicitly and subtly different we are from one another.

* True statement, not a joke.

Figure 1.4 **The DNA Drawer** The way genes are expressed is a little like pulling recipes out of a drawer. They may be there, but it can take some work to find them.



Epigenetics in Action: What It Means to You

By about this time, we suspect that you're asking yourself where you can buy yourself some epigenetic Post-it notes, because they sure as heck aren't in aisle twenty-three of Walmart. The way epigenetics works during pregnancy is that stressors in the mother's environment cause changes in the gene expression patterns of the fetus. Translation: The chemicals your baby is exposed to in utero via the foods you eat and the cigarettes you don't inhale serve as biological light switches in your baby's development. On, off, on, off—you decide how your child's genes are expressed, even as early as conception. You don't have total control, though. We still don't know how you can change your baby's eye color or how old he'll be when his hair starts receding. But we do know how to influence some really important factors like your child's weight and intelligence.

So there's an important reason why we're able to turn certain genes on and off. Our bodies have to adapt to a changing environment; that's how a species survives, after all. But our ability to adapt would be much too slow if we had to wait generations for our genes to change through random mutation (the classical theory of evolution). Our bodies need some other kind of mechanism to allow us to adapt. Epigenetics gives our bodies the ability to influence which genes will be turned on—or as the scientists (and now you) say, expressed—or off, or partially on, depending on our immediate environment. Even more amazing is the fact that epigenetic changes don't occur just when a baby is developing in the womb—they can also occur throughout life and can be passed down from generation to generation.

One of the best examples of epigenetics is called fetal programming. This refers not to teaching your child to use the remote control before birth, but rather to changes in gene expression that affect the growth and functioning of the placenta, the amazing organ that filters nutrients, oxygen, and waste between mother and baby (more on the placenta in chapter 2). If a mother's genes for placental growth are turned off and the father's genes are expressed, a thicker, richer placenta develops and channels more nutrients to the fetus. This puts more strain on the mother, because it both deprives her of nutrition she needs to remain healthy and causes her to carry a larger baby, which is associated with a host of risks. (See chapter 4.) If, instead, the mother's genes are expressed, a smaller placenta develops and fewer nutrients get to the baby. In this case, the mother is protecting her interests—if this baby doesn't make it, she can always try again.

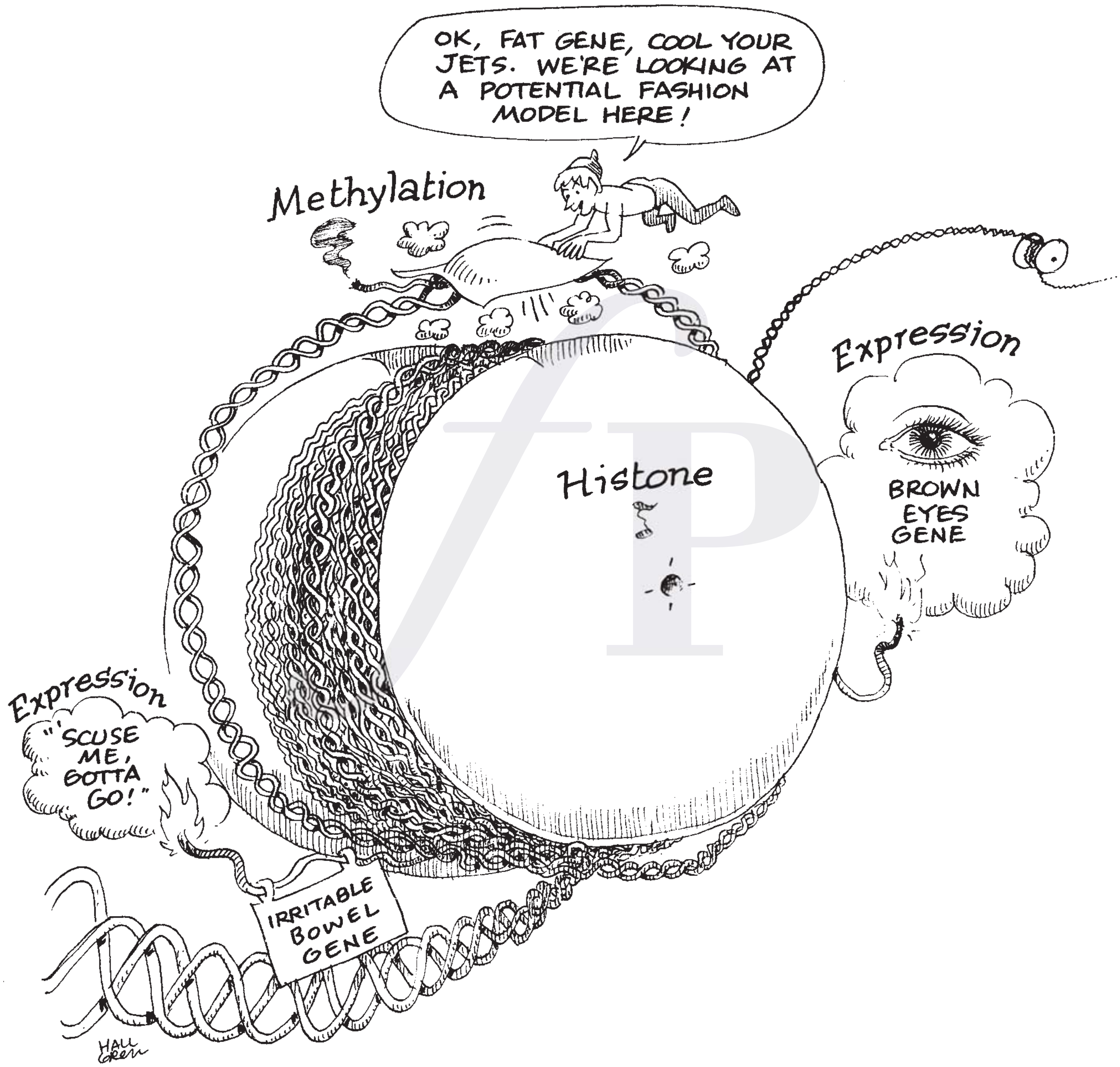
Fetal programming also occurs when a baby is malnourished in utero—either because mom doesn't eat properly during her pregnancy or because environmental toxins compromise the placenta's ability to deliver adequate nutrition (more on this in the next chapter). In either case, you get the same result: a smaller baby. You may be asking, "So what if my baby is a couple of pounds smaller than average at birth? So what?" Here's what:

> **Factoid:** All of the epigenetic changes that you can make during the development of your fetus don't just change the way your child's genes are expressed. These changes can also be passed down from generation to generation—meaning that the small changes you make today can affect generations long after you've been said good-bye to—so your responsibility for creating a healthy environment for your offspring is even bigger than you may have thought.

In utero, if you feed your baby fewer nutrients, you're programming your child to expect an environment of deprivation ex utero. So genes that cause the fetus to be very thrifty, metabolically speaking, are turned on. Once the baby is born and the external environment is not one of deprivation, that child will conserve more of the food it gets and become fatter, exhibiting what's known as a thrifty phenotype (we refer to this in chapter 2). More fat storage equals an increased likelihood of becoming overweight and developing heart disease, type 2 diabetes, stroke, cancer, and osteoporosis as an adult. It's similar to the reason why starvation diets don't work: When your body thinks it's faced with famine, it goes into fat-storage mode and your metabolism slows. Poor fetal nutrition may also permanently change the structure and development of vital organs such as the brain. In some cases, these epigenetic changes can even be passed on to future generations as well.

We do want to make one thing clear: If this is not your first pregnancy, don't beat

Figure 1.5 **Time for Change** Through processes called methylation and acetylation, you can alter the way genes are expressed, as well as determine which genes are expressed. In other words, you can take certain actions that will influence whether some genes come to the forefront and whether others get locked away forever.



yourself up that you didn't know much about epigenetics the last time around. None of us did, either. While epigenetics plays a role in what happens before birth, as we mentioned earlier, you can actually regulate gene activity after birth—for this child, for previous children, even for yourself. Also, if you fear you've already done something damaging to this baby, rest assured that human beings are a resilient lot; otherwise we'd have died out millennia ago. Let's face it: Since 50 percent of pregnancies are unplanned, plenty of women inadvertently expose their babies to toxins like alcohol and tobacco. The key is to stop and make a YOU-turn,* reversing damaging behavior as soon as possible. Even the damage caused by smoking can be offset if you quit in the early part of your pregnancy.

Another way to think about how epigenetics works is to think about how music is created. Consider your DNA to be the musical composition that will determine the individuality of your child; after all, there are zillions of way to put musical notes together. But the catch is that there are many different ways to interpret any given song. The way Johnny Cash sang a song would be different from the way a rocker would today and is way different from how a philharmonic orchestra would perform it.† Same song, different interpretations, and different results.

You and your partner each has your own set of DNA, and through your recent rendition of a boogie-woogie-woogie, you made your own biological song in the form of a baby. That genetic coding is indeed fixed, but you still have the ability to interpret the song and change the way your offspring's genes are expressed. That, dear friends, should be music to your ears.

* A YOU-Turn, as we introduced in *YOU: On a Diet,* refers to the fact that it's not too late to make changes. The key is to identify when you've gone down the wrong road and get back on the right course as soon as you can.

† Not that one would.

YOU TIPS

The reason epigenetics is so important isn't because someday you'll be able to tag your baby's genes for blond hair, a composer's brain, or the ability to hurl a 98 mph fastball. It's because epigenetics teaches us this: The environment that you provide for your offspring—through what you're eating, drinking, smoking, or stressing about—is what your child will program herself to expect of the world she's entering. Based on what you're doing right now, she's forecasting her future environment. And if the programming for gene expression doesn't match that environment, problems can occur. So your challenge—dare we say your responsibility—is to provide little Dolly with a healthy environment now so that her "internal programming mechanism" predicts and can respond to a healthy environment later. Many of the tips we outline throughout the book are based on this fundamental idea, but here we'll discuss some of the major things you can do right away to positively influence the way your baby's genes are expressed.

Add Folate. Your baby needs the nutrient folate because it has a direct effect on DNA. Folate is an essential ingredient of one of the building blocks of DNA, thiamine. Without folate, your body may substitute a less effective backup building block called uracil, which can cause birth defects, primarily spina bifida. Also, a lack of folate has been shown to increase childhood cancer rates by more than 60 percent. A startling statistic, for sure, but one that reinforces the notion we just talked about: in utero nutrients influence out-of-utero health. If you're even thinking about getting pregnant, you need to supplement with 400 micrograms of folic acid (the synthetic form of folate) every day.

Detox. As we'll discuss in chapter 2, your placenta acts as a filter that allows nutrients to pass from mother to child. It's a nice system, except for the fact that it lets toxins through, too. Of course, the last thing you want is to provide your bubby an in-womb environment that resembles a landfill. We urge you to get rid of the most harmful toxins in your life as soon as you decide to get pregnant or once you find out you are. Some major toxins are:

- Tobacco (see below).
- Methylates. Found in hot dogs and lunch meats, they unwind DNA that's not supposed to be unwound.
- Alcohol.
- Marijuana.
- Phthalates. These chemicals, found in plastics and cosmetics, mimic estrogens and have been linked to feminized fish; they increase when you microwave foods in plastic.
- Aerosolized products such as turpentine, toluene, and paint thinner. Let your partner paint the baby's room. And aggressively air it out before you and the baby come near it—breast milk can carry such stuff too.
- Radon. This radioactive element comes from the ground and gets trapped in modern houses. It needs to be ventilated away if found.
- Fluorotelomers. These are found in paints and coatings and in stain repellents applied to materials such as carpets, paper, packaging, and textiles.
- Bisphenol-A. Found in hard plastic bottles; none is commonly obtained when you drink water from undamaged plastic bottles.
- Other bad hydrocarbons, such as those found in unmarinated grilled meats.
- Mercury, lead, and other heavy metals. Stay away from coal-fired power plants.

Also, if your occupation exposes you to chemicals, find out what chemicals are involved and seek advice as to their fetal safety.

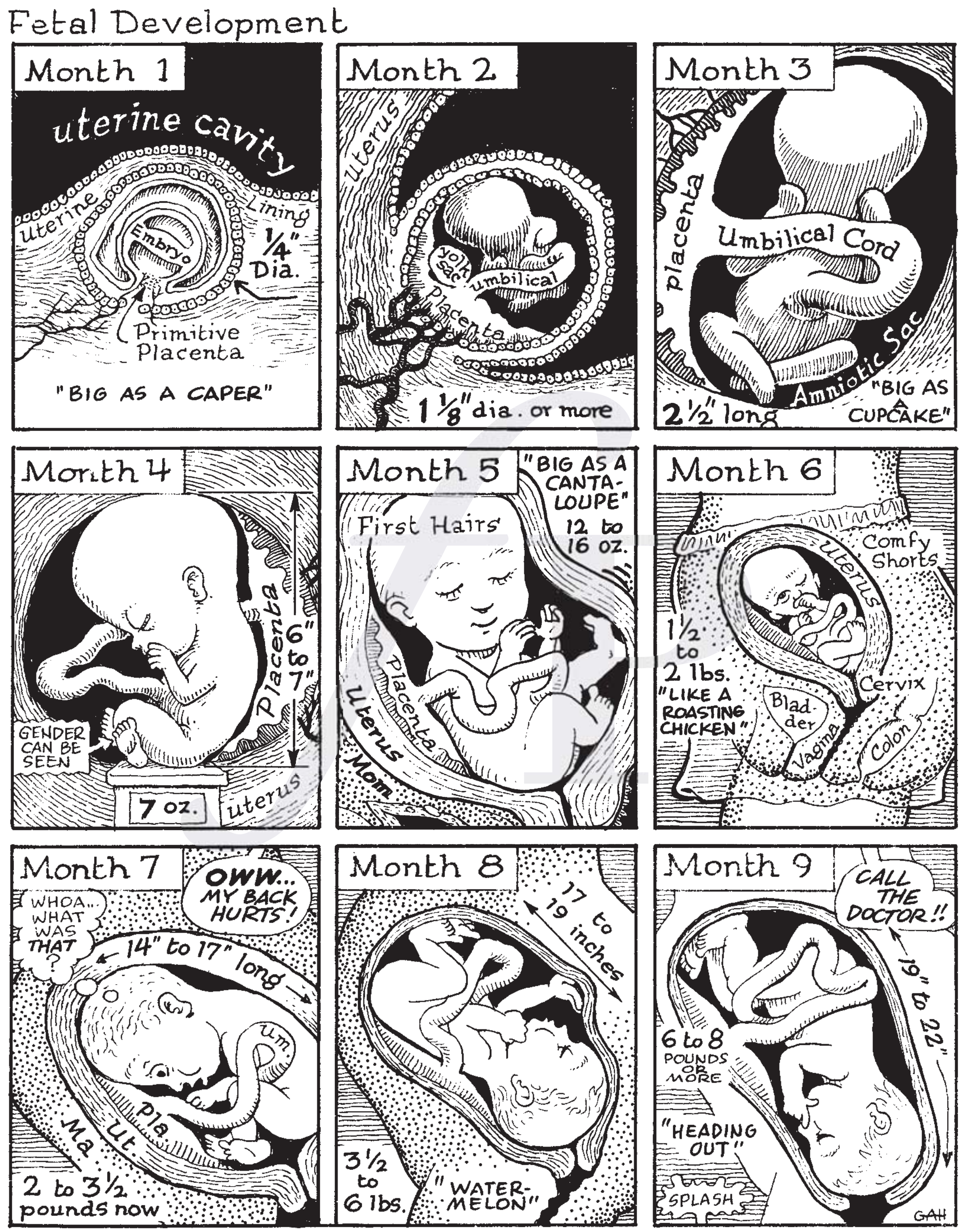
Put Out the Fire. You knew you were going to get the talk at some point, so now's as good a time as any. Please don't sentence your child to nine months inside a smoky bar. Tobacco turns on genes that are later linked to the growth of cancers, as well as inflammation in arteries, which in turn leads to heart attacks, strokes, wrinkles, and impotence. Most important for you, smoking also limits blood flow to the uterus by causing inflammation in the uterine arteries, thus making it harder for beneficial nutrients to travel from mom to child. If you're currently a smoker, please see www.realage.com for our Breathe-Free, addiction-busting program.

Know the Limit. In doctors' offices, message boards, and nail salons everywhere, debates rage about the role of alcohol in pregnancy. Surely we all know that excessive alcohol during pregnancy is the biological equivalent of a lightning storm, tornado, and tidal wave all wrapped up into one. But still, many ask: Is one drink okay? While moderate alcohol has many health benefits, we don't recommend any alcohol during pregnancy. Alcohol is a toxin to developing brain cells even at minor levels, so don't take any chances. Further, a little alcohol changes brain functioning, predisposing your baby to alcohol problems later in life, as well as decreasing her brain development. A big reason to avoid it: If something does go wrong, you don't want to be guilt ridden thinking that you didn't do everything you could have to ensure the health of your child.

Squash the Radiation. To protect your baby from the toxic effects of radiation, you should avoid X-rays and other forms of radiation during pregnancy. Radiation alters the DNA of cells as they replicate, which is why it is used in cancer therapy (cancers reproduce faster than regular cells). Fetal cells reproduce the fastest and are the most susceptible to injury, which may lead to miscarriage or birth defects, or predispose your child to cancer later in life. Avoiding radiation may also mean that you should consider your flying habits. Flying for thirty hours exposes you to the same dose of radiation as one chest X-ray. Does that mean that you're automatically harming your child if you whisk off to the Caymans when you're four months pregnant? No. But if you're being diligent about taking all precautions, it's worth thinking about whether each trip you are planning can wait.

See the Dentist. You're more likely to be thinking about your appointments with your ob/gyn or midwife than you are about those with your dentist. But you should get your teeth cared for and cavities filled, ideally, six months before you become pregnant. While you are pregnant, maintain your schedule of regular checkups for dental health. However, try to wait to get any new cavities filled until after your baby is born, unless the procedure is absolutely necessary. (To be extra cautious, you can avoid breast-feeding for two weeks after dental work.) Traditional fillings contain mercury, which releases mercury vapor that you absorb, and even the composite ones have been associated with releasing phthalates (see page 38) when they harden. Even though no conclusive studies link fillings to fetal health abnormalities, one can surmise that these chemicals may be harmful to a developing fetus.

Figure 1.6 **Miracle Grow** Amazing milestones happen at every step along the way as a fetus develops. Heartbeats, taste buds, fingernails, the sense of touch—when you consider everything that develops in utero, you really can appreciate that is a womb with a view.



The Time of Your (in Utero) Life

Mark the milestones in your baby's development. All ages are based on clinical age; that's two weeks from the first day of your last period.

6 Weeks
Heart is formed, circulation is established. A big part of the lungs is formed, as well as the fingers, toes, and parts of the face, like the lips.

7 Weeks
Fetus can produce urine. Bubbles in the eye area collapse into cuplike structures.

9 Weeks
Immune system starts to develop, with the formation of B cells, a type of white blood cell that assists in fighting infection. Nostrils are formed. Baby is the size and shape of a kidney bean.

10 Weeks
Eyes move to the front of the face, and the eyelids form and fuse shut (they separate late in the second trimester). Fetus begins to squint, open its mouth, and make small movements with its fingers and toes.

11 Weeks
The chin, eyelids, and arms can all sense touch.

12 Weeks
Taste buds develop and mature. Easy on the anchovies, mom.

14 Weeks
Immune system ramps up, with the formation of T cells. Lots of gut chemicals can be detected, including bilirubin from the liver and insulin from the pancreas. Baby starts to develop skin, hair,

and nails. Swallowing begins. The entire surface of the body can sense touch. Fetus size: about that of an orange.

16 Weeks

External genitalia spotted. The 100 million neurons that form in the primary visual cortex develop between now and twenty-eight weeks. Respiration develops. Size: about that of a grapefruit.

20 Weeks

Ears stick out of the head. Downy hair covers the body. Size: 300 grams, or the weight of two iPods.

25 Weeks

Fetus can respond to sounds. Be careful what you say.

26 Weeks

Ability to suck. Ability to hear sounds. Eyebrows and eyelashes detectable. Size: 630 grams (the weight of about three oranges). Almost half of babies that reach this age will survive if delivered.

29 Weeks

Lungs with fluid in them begin to expand and compress, simulating breathing movement.

30 Weeks

Eyes can sense light, and the ability to smell begins. Fetus can suck and swallow, to help develop the gastrointestinal (GI) system. Plus, it can also hic-hic-hiccup and even breathe, which is really helpful if it is born this early, since 90 percent will survive. Size: 1,100 grams, or the weight of one pineapple.

34 Weeks

Skin is red and crinkled. Fat starts to be deposited to round out fetus. Reflexes like blinking and grasping are set, and the fetus is actually settling into noticeable sleep patterns. Size: 1,800 grams, or the size of the average Chihuahua.

36 Weeks

If it hasn't already, baby begins the descent into the pelvis to prepare for delivery. Fingernails reach the end of the fingertips.

37 Weeks

Lungs are considered mature, and baby is not considered premature if delivered. This is considered full-term.

38 Weeks

With formation of more fat, body becomes more rotund, less wrinkly. Size: 2,500 grams, or the weight of a lightweight laptop computer.

40 Weeks

Normal gestation period ends. All systems go.