1. RESTful API Design Principles

- **Clear and Consistent Resource Naming: Use nouns that accurately reflect the resources your API manages (e.g., */products*, */users*).**
- **Clear Resource Naming:** Use descriptive nouns like `/products` or `/orders`
- **Standard HTTP Methods:** Use correct HTTP verbs for CRUD (POST, GET, PUT, DELETE).
- **Meaningful Status Codes:** Ensure proper status codes for success, client errors, and server issues.

Example:

```
java
Copy code
@GetMapping("/products/{id}")
public ResponseEntity<Product> getProductById(@PathVariable Long id)
{
    Optional<Product> product = productService.findById(id);
    return product.isPresent() ?
        ResponseEntity.ok(product.get()) :
        ResponseEntity.notFound().build(); // 404 if not found
}
```

Explanation: This example fetches a product by ID. If the product isn't found, it returns `404 Not Found`.

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2. Leverage Spring Boot Annotations

Using Spring Boot annotations simplifies your controller logic. For example, annotations like `@RestController` and `@RequestBody` make your code expressive and readable.

- **@RestController**: Marks controllers as returning JSON or other structured data by default.

- **@RequestMapping**: Defines the base path for a controller's endpoints.
- **@GetMapping**, **@PostMapping**, **@PutMapping**, **@DeleteMapping**: Specify HTTP methods for endpoints.
- **@PathVariable**: Captures path variable values (e.g., /products/{id}).
- **@RequestBody**: Deserializes request body content into a Java object.
- **@ResponseBody**: Indicates a method returns the response body (often used implicitly with *@RestController*).

Example:

```
@RestController
@RequestMapping("/users")
public class UserController {

    @GetMapping("/{id}")
    public ResponseEntity<User> getUserById(@PathVariable Long id) {
        return ResponseEntity.ok(userService.findUserById(id));
    }

    @PostMapping
    public ResponseEntity<User> createUser(@RequestBody User user) {
        return
ResponseEntity.status(HttpStatus.CREATED).body(userService.saveUser(u
ser));
    }
}
```

Explanation: Here, `@RestController` automatically serializes responses as JSON. `@RequestMapping("/users")` defines the base path for all endpoints.

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3. Embrace Dependency Injection (DI)

With Spring's DI, you inject dependencies into your classes, keeping them decoupled and testable.

- Use @*Autowired* to inject dependencies (services, repositories) into controllers.
- Promote loose coupling and testability.

Example:

```
@RestController
public class ProductController {

    @Autowired
    private ProductService productService;

    // ... other controller methods
}
```

Explanation: `@Autowired` injects `ProductRepository` into `ProductService`, promoting modular design.

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4. Implement Exception Handling

Handle exceptions gracefully using `@ControllerAdvice` and `@ExceptionHandler`. This keeps your API responses clean and consistent.

- Create custom exception classes for specific API errors.
- Use @*ControllerAdvice* and @*ExceptionHandler* to handle exceptions gracefully and return appropriate error responses.

Example:

```
@ControllerAdvice
public class ApiExceptionHandler {

    @ExceptionHandler(ProductNotFoundException.class)
    public ResponseEntity<ErrorResponse>
handleProductNotFound(ProductNotFoundException ex) {
        // ... create error response with details
        return
ResponseEntity.status(HttpStatus.NOT_FOUND).body(errorResponse);
    }
}
```

Explanation: This setup provides custom error messages for `ProductNotFoundException` with proper status codes.

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5. Use DTOs for Data Representation

DTOs (Data Transfer Objects) decouple API input/output from the internal models, improving maintainability.

- Create dedicated classes (DTOs) to represent data exchanged between API endpoints and services.
- Improve code readability, maintainability, and data encapsulation.

Example:

```
public class ProductDto {
    private Long id;
    private String name;
    private Double price;
```

```
    // Getters and Setters
}
```

Explanation: Instead of using the entity directly, we use `ProductDto` to handle incoming and outgoing data, reducing tight coupling.

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6. Security Best Practices

Security is crucial for APIs. Use Spring Security to add JWT authentication and authorization.

- Implement authentication and authorization mechanisms (e.g., JWT, Spring Security).
- Validate and sanitize user input to prevent common web vulnerabilities (XSS, SQL injection).
- Secure communication using HTTPS.

Example:

Adding JWT-based security:

```
java
Copy code
@EnableWebSecurity
public class SecurityConfig extends WebSecurityConfigurerAdapter {

    @Override
    protected void configure(HttpSecurity http) throws Exception {
        http.csrf().disable()
            .authorizeRequests()
            .antMatchers("/api/auth/**").permitAll()
            .anyRequest().authenticated()
            .and()
```

```
.sessionManagement().sessionCreationPolicy(SessionCreationPolicy.STAT
ELESS);
    }
}
```

Explanation: This disables session-based authentication and ensures stateless JWT token-based security.

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7. API Versioning

Versioning helps maintain compatibility with older clients when updating your APIs.

- Consider versioning APIs to manage changes and maintain compatibility with clients.
- Use path versioning (e.g., */api/v1/products*) or header-based versioning.

Example:

```
@RestController
@RequestMapping("/api/v1/products")
public class ProductControllerV1 {

    @GetMapping("/{id}")
    public ResponseEntity<Product> getProductV1(@PathVariable Long
id) {
        return ResponseEntity.ok(productService.findById(id));
    }
}
```

Explanation: Use versioning in the path (`/api/v1`) or through request headers to support multiple API versions.

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8. Documentation with Swagger

Interactive API documentation is essential for developer collaboration. Use Swagger for auto-generating documentation.

- Use Springfox Swagger or OpenAPI to generate interactive API documentation.
- Improve developer experience and API discoverability.

Example:

```
@EnableSwagger2
@SpringBootApplication
public class ApiDocumentationConfig {
    @Bean
    public Docket api() {
        return new Docket(DocumentationType.SWAGGER_2)
            .select()
            .apis(RequestHandlerSelectors.basePackage("com.example"))
            .paths(PathSelectors.any())
            .build();
    }
}
```

Explanation: With `@EnableSwagger2` and a few configuration settings, you can auto-generate Swagger-based API docs.

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9. Testing Your APIs

Testing ensures your API's reliability. Use JUnit for unit tests and Mockito for mocking dependencies.

- Write thorough unit and integration tests for controllers, services, and repositories.
- Ensure API functionality and robustness.
- Consider using tools like Mockito or JUnit.

Example:

```
@RunWith(SpringRunner.class)
@WebMvcTest(ProductController.class)
public class ProductControllerTest {

    @Autowired
    private MockMvc mockMvc;

    @MockBean
    private ProductService productService;

    @Test
    public void getProductById_ShouldReturnProduct() throws Exception
{
        when(productService.findById(1L)).thenReturn(Optional.of(new
Product(1L, "Laptop", 1200.0)));

        mockMvc.perform(get("/products/1"))
            .andExpect(status().isOk())
            .andExpect(jsonPath("$.name").value("Laptop"));
    }
}
```

Explanation: Use `MockMvc` for testing controllers and `@MockBean` to mock service layers.

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10. Monitoring and Logging

Log requests, responses, and errors to understand your API's performance and detect issues early.

- Implement logging to track API requests, responses, and errors.
- Use tools like Spring Boot Actuator to monitor application health and performance.
- Enable early detection and troubleshooting of issues.

Example:

```
@RestController
public class LoggingController {

    private static final Logger logger =
LoggerFactory.getLogger(LoggingController.class);

    @GetMapping("/products/{id}")
    public ResponseEntity<Product> getProduct(@PathVariable Long id)
{
        logger.info("Fetching product with id: {}", id);
        return ResponseEntity.ok(productService.findById(id));
    }
}
```

Explanation: Use `Logger` to log every request and response, aiding in troubleshooting and monitoring.
